Knowledge.

With which is incorporated Hardwicke's Science Gossip, and the Illustrated Scientific News.

A Monthly Record of Science.

Conducted by Wilfred Mark Webb, F.L.S., and E. S. Grew, M.A.

APRIL, 1913.

EXPERIMENTS ON LIQUID DROPS, GLOBULES, AND COLUMNS.

By CHAS. R. DARLING, A.R.C.Sc.I., F.I.C.

II.

LIQUID COLUMNS.

If a large drop of liquid be formed in a shallow layer of water (after the manner described in the previous article), so that the drop reaches the bottom of the vessel before parting, it will generally spread so as to take the shape of the lower portion of the vessel; and if the upper part of the drop be brought to the surface of the water, and the delivery tube be detached, a column of the liquid may form. In practice, however, it is not easy to obtain a liquid column in this manner; but by carrying out the following instructions the formation may be secured with ease and certainty:—Take a test-tube 2·5-cms. (1-in.) or more in diameter, and nearly fill the hemispherical end with water. Incline the tube, and pour *aceto-acetic ether* very gently down the side, until the level of the liquids rises about one centimetre in the cylindrical part. On erecting the tube, a column, similar to that shown in Figure 116, will be formed, the upper part being attached to the surface of the water, whilst the lower end rests on the test-tube. The curved sides of the column will be seen to possess a most graceful outline, and are bounded by water. The shape of the column thus formed may be varied by employing a wider tube, in which case the column will be relatively narrower at the top; or by gradual additions of water, which stretch the column longitudinally, causing the diameter at the middle to diminish until breakage occurs. The change produced by adding successive small quantities of water is shown in Figures 117–120, which represent four stages in the stretching of a column of *iso-butyl benzoate*. The varied outlines of the columns are extremely pleasing, and the last picture of the series shows the width at the moment of breakage, which in this case occurred during exposure, the column appearing in faint outline. After severance, the greater portion sinks to the bottom of the tube, the remainder hanging from the surface in the form of a globule. It may be added that the water should be allowed to trickle down the side of the tube, as, if dropped directly on to the column, water-bubbles are formed which impair the shape.

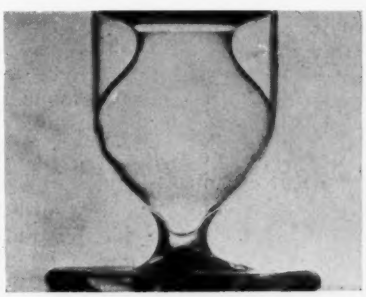

Figure 116.
A column of aceto-acetic ether in water.

It might be expected that any liquid slightly denser than water would, if insoluble, form columns in the manner described. This is not the case, however, for reasons which at present cannot be entirely

explained. Orthotoluidine, for example, does not lend itself to these formations; and in the case of aniline a vessel of five centimetres in diameter is required, and even then it is difficult to prevent the column from sticking to the side, and so spoiling the shape. Iso-butyl benzoate, as purchased, varies considerably; the first sample procured by the writer behaved ideally, as in Figure 117, but three other specimens since obtained have entirely failed to produce satisfactory columns. Hence it is recommended, when it is desired to produce a column with certainty, to use aceto-acetic ether, which has given uniformly successful results.

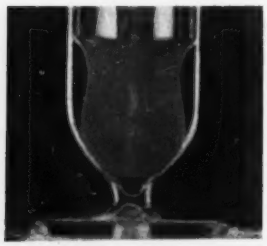

*FIGURE 117.

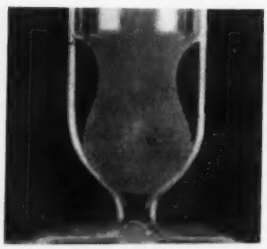

FIGURE 118.

THE MOVEMENTS OF LIQUID GLOBULES ON A WATER SURFACE.

Investigations of movements on the surface of water have hitherto been restricted to the rotation of camphor and a few other solids, and to the formation of films of oil, which spread across the surface rapidly in all directions from the spot on which the oil is placed. Whilst experimenting with aniline and orthotoluidine with a view to the formation of drops, the writer observed that the globules which floated on the surface of the water showed movements of a type not previously recorded, and for which no satisfactory explanation has yet been given. So far no photographs have been secured which give an idea of the nature of the movements in question, and hence it will be necessary to resort to drawings in order that an idea may be formed as to the nature of the phenomena. The accompanying illustrations are the work of Mr. W. Narbeth, one of the writer's students, and correctly represent certain stages; but to observe the movements to full advantage it is necessary to perform the experiments. In order to produce surface globules, a dish, ten centimetres or more in diameter, is taken—a photographic dish answers well—and rinsed several times with tap-water before it is filled. One or two drops of the liquid under trial are then allowed to trickle down the side of the vessel on to the water, when globules, sooner or later, will form. A dropping bottle or fine pipette will be found convenient for regulating the quantity of liquid, which, if too large, may obscure the movements.

When a drop of red-coloured, commercial aniline is thus floated on clean water, globules are formed which display movements best expressed by the word "twitching." What actually occurs is that the globule is stretched at first, but afterwards recoils, forming a globule of less diameter and greater depth. This alternate expansion and contraction is accompanied by the detachment of small globules from the rim, which becomes indented as shown in the largest globule depicted in Figure 121, the small globules being formed from the protuberances. After shrinking, the appearance presented is indicated by the second largest globule in Figure 121, which is shown surrounded at a distance by the small, detached globules. Finally, owing to continued partition at the rim, the diameter diminishes until, at a certain point, the movement ceases, leaving a number of small globules floating tranquilly on the water. If only a minute quantity of aniline be used, the globules may disappear entirely by spreading over the surface or by solution.

The next movement to be described is even more remarkable, and was first obtained by the author with orthotoluidine, but was only shown to perfection by one sample. Other quantities of the liquid since obtaincd have failed for some reason to produce equally good results; but the same movement is exhibited by the liquid *xylidine 1–3–4*. The globules formed when one or two drops of this liquid are allowed to run on the surface of water are endowed with remarkable activity. Simultaneously, all the globules above a certain size become indented on one side only, so as to resemble a kidney in shape, when each is projected violently across the surface of the water. Some of the forms taken by the globules are shown in Figure 122, in which it will be seen that in the process fragments are broken off the larger ones; and sometimes the indentation spreads to the opposite side and cuts the globule into two. A period of repose then follows, in which the globules all possess a circular outline; when suddenly, moved by a common impulse, all the larger globules again assume the kidney shape and dart across the surface. This continues until a number of small globules are left quietly floating on the surface; or the whole may disappear by spreading and solution. Sometimes the movements will continue, with increasing sluggishness, for an hour or more. The direction of motion across the surface is always away from the indentation, as if the globules were pushed by the

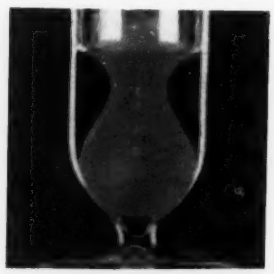

FIGURE 119.

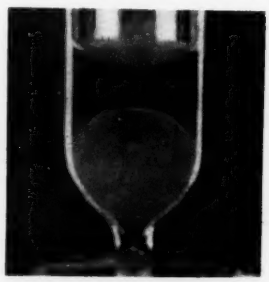

FIGURE 120.

*FIGURES 117–120. A column of iso-butyl benzoate, stretched by adding water until breakage occurs. Four stages.

force which forms the cavity. Professor Boys has facetiously suggested that this should be termed the "kidney-disease" experiment.

The manner in which a film of liquid on the surface of water breaks into globules is shown in Figure 123, and is best observed with *dimethyl-aniline*. When a very small drop of this liquid is allowed to trickle on to water, it spreads out into a film of irregular shape, from the thin edges of in the centre and remain on the surface in the form of rings, interspersed with plates containing several holes.

The surface movements described are only selected examples of a large number observed by the author; and it will be noted that the indentation of the edges of the globules or films is a common feature. There is little doubt that these indentations arise from the interplay of the tensions at work, but it is not evident why an aniline globule should be uniformly

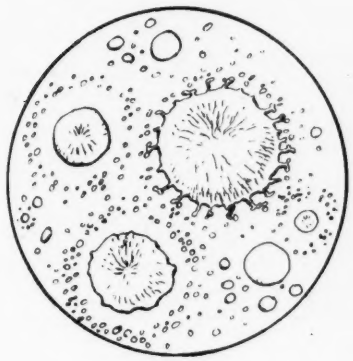

FIGURE 121.
Aniline globules on a water surface.

FIGURE 122.
Movements of orthotoluidine globules on a water surface.

FIGURE 123.
A film of dimethyl-aniline breaking into globules.

which a number of small globules immediately form. Indentations then appear round the edges, which branch out into coral-like shapes, and simultaneously holes appear in the film from which similar branchings arise. The various channels unite in numerous places, thus cutting the film up into numerous small portions, each of which immediately becomes circular in outline; and by this beautiful process a film is resolved into globules in a few seconds. In order to see this remarkable movement to advantage, an exceedingly small drop of liquid must be used, and the water must be perfectly clean tap-water. The same action can be observed with *quinoline*, in which case the division occupies a much longer time; and the globules formed, after a few minutes, become perforated indented, whilst only one side of a globule of orthotoluidine is attacked. The movements introduce new features which do not appear to be capable of explanation by the usual theories of surface tension.

It may be added that the movements may be shown to great advantage by the aid of a lantern provided with a horizontal stage, vessels with a bottom of plate-glass being preferably employed. Sufficient materials for showing the phenomena a large number of times can be procured at a small cost; and when once seen it will be realised how completely inadequate any verbal description must of necessity be to convey to the mind the beauties of the movements. Hence the writer hopes that all who read will try the experiments for themselves.

NEGRO MAN IN BRITAIN.

UNDER the auspices of the Celtic Union, Edinburgh, a lecture was delivered on the 21st of February, by W. J. Edmondston-Scott, M.A., author of "Elements of Negro Religion," in the Philosophical Institution, on "The Age of the Stone-circles: or Negro Man in Britain." Mr. David MacRitchie, F.S.A., Scotland, presided.

The lecturer discussed the many aspects of the "pre-Aryan" problem with particular reference to pre-Celtic Britain, its ethnology, history and antiquities. He showed that the deeper scientific researches descended into European Ethnology, the more and more assertive became the Negro type of physiognomy — as evidenced by the anatomical characters of the oldest pre-historic skulls,—a fact which argued the former existence of a negro race of Aborigines in Middle and Western Europe, most probably associated with a milder and more equable climate than ours; that the character and contents of Cave-deposits and River-drifts testified to general differences in Negro Culture; and that the infinite variety of Culture-stages represented from Mousterian to Neolithic and later times was just such as prevails universally throughout Modern India. He indicated how man's antiquity in Europe resolved itself into the problem of the age of India's native civilisations, whose pre-historic culture in every stage and form had been diffused over the European Peninsula at a very remote period; and how the Eastern origin of this negro species pointed to its affinities with the Kolarian Aborigines of Bengal—the only negro race in the whole Asiatic mainland—from one of whose ancient tribes, now represented by the Baske, were descended the Basques of Europe, as could be proved from the remains of their archaic speech and the vestiges of Kolarian culture among them. On linguistic and ethnological grounds the lecturer concluded that the so-called "Pre-Aryan Problem" vanished with the solution to the old-time mystery about the origin of the Basques, and was one to which the scientific study of the Kolarian languages offered the only means of solution.

XUM

FIGURE 124. The Site of the Emerald Mines.

PREHISTORIC EMERALD MINES.

By LEOPOLD CLAREMONT,

Author of "Ceylon, the Island of Jewels," "The Gem-Cutter's Craft."

IN 1812, a Frenchman named Cailliard rediscovered a series of anciently-worked emerald mines, the history of which is lost in antiquity.

They were found in a desolate mountain range which lies west of, and parallel to the Red Sea between the 24th and 25th lines of latitude.

He was one of a party of explorers sent by Mehemet Ali Pasha, to endeavour to locate the mines of Ethiopia, whence the ancients obtained their emeralds, and to which old inscriptions refer, but of which all trace had been lost. It is a matter of history that Cleopatra caused her portrait to be engraved on emeralds, and there is also the legend of Nero viewing the burning of Rome through one of these stones. Moreover, emerald jewels are to-day found in the ruins of ancient cities, and enclosed within the bindings of Egyptian mummies, so there can be no doubt that the gems were much appreciated at a most remote date.

The result of Cailliard's investigations and also those of a British expedition of recent years, was the discovery of quantities of emeralds of large size but poor quality, which in every respect resemble the ancient jewels referred to above.

FIGURE 125. A good geological section.

There is little doubt but that the Frenchman was successful in his quest, and that the mines which he found are the actual ones from which the gems were taken in ancient times. For convincing evidence that this is the case, is the appearance of the mines at the present time.

These mines, to which the name "Cleopatra Emerald Mines" has been given, are situated in a barren region traversed by several picturesque winding valleys, the principal of which is known as the Wâdy Djemel.

A wâdy is a valley formed by an ancient water-

FIGURE 126. A wâdy of coarse sand.

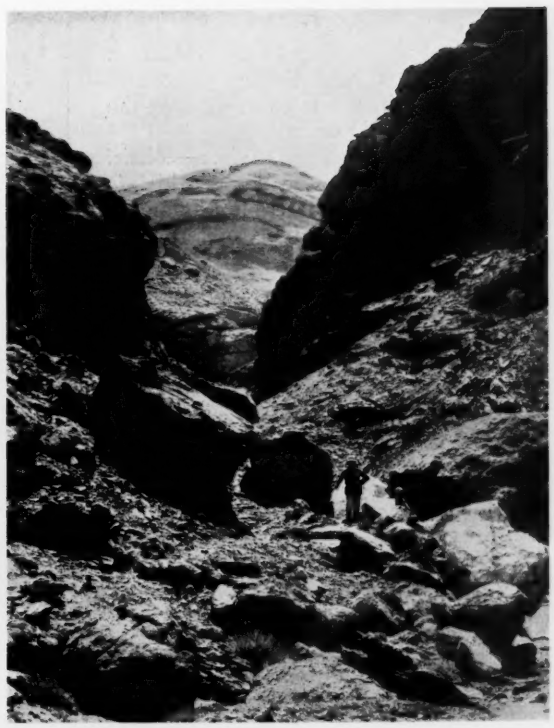

FIGURE 127. An artificial passage-way.

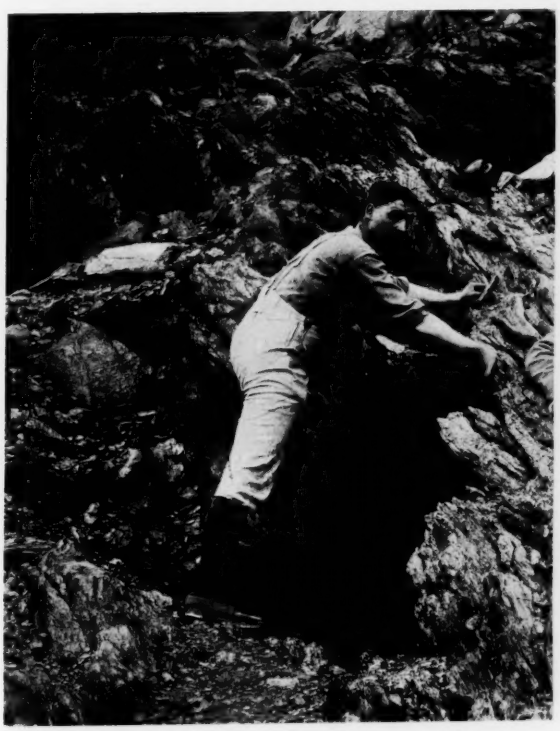

FIGURE 128. The entrance to one of the emerald mines.

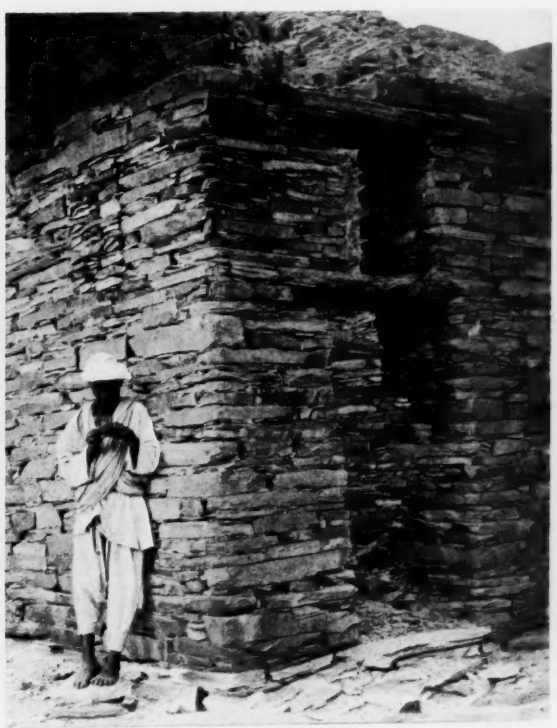

FIGURE 129. Part of one of the ancient buildings.

XUM

course which has during the lapse of ages become dry or nearly so.

The hills consist of strata of hornblende, soapstone, mica schist, talc schist and augite. It is in the mica schist that the crystals of emerald occur.

In several localities, viz.:—Sikait, Nugrus and Zebara, the schist which is a comparatively soft material, is found to be honeycombed with long subterranean tunnels and chambers, some of which are large enough to contain hundreds of men at work. Many of the small winding passages are situated one above the other, and the division between them is so slight that unless the explorer exercises great care, he will, as he crawls along, put his foot through into the tunnel below.

FIGURE 131.

A typical view of the mountains where the emeralds are found.

That these excavations were made anciently is shown not only by the primitive nature of the work, but by the finding of such articles as tools, lamps and baskets, which evidently were left behind by the early workers when for some unknown reason they decided to abandon the mines. Some of the cavities are shored up with wooden supports which, although apparently of great age, are still intact.

It has been ascertained that some of the objects found belong to as early a period as 1660 B.C., but the date at which the excavations were commenced is quite unknown.

There are also indications that after the workings were originally deserted, they were at several subsequent periods visited and re-worked possibly by members of a race altogether different from their predecessors. This assumption is warranted by the fact that much of the obviously later work is executed with greater skill than the earlier, and that it is followed by some of a primitive nature. It is probable that the Romans were responsible for the best of the work done.

When working the mines the workers evidently dug round or over any mass of hard rock which they came across, and in some cases they apparently were stopped altogether by some such impediment; nevertheless, the excavations represent great skill and ingenuity, combined with a colossal amount of physical toil.

A striking example of the magnitude of the work done is shown in Figure 127 depicting an artificial roofless passage-way from one part of the mine to another. In the picture the cutting may be seen immediately to the right hand side of the standing figure near the centre.

FIGURE 130.

Interior of ancient building showing walled-up recesses.

Signs are not wanting that at a far distant period the district in which the emerald mines are situated was the centre of a large industrious population, probably chiefly devoted to mining operations.

Numerous buildings of this ancient race still remain as lasting monuments of skill, endurance and enterprise, as will be clearly appreciated by the illustrations which are here given. The purposes for which they were erected can only be surmised after such a lengthy lapse of time, but many of them have the appearance of having been forts and watch towers, perhaps built to protect the mines from invasion, whilst others may have been dwelling-houses or barracks, and some were certainly used as temples.

For the most part the edifices consist of unshaped flattish stones, closely packed and arranged to form the walls, whilst

others are hewn out of the solid rock. There are present a few examples of ancient masonry in which the stones are cemented together with no little skill, and there are also wells of considerable depth, formed of stones closely cemented in a similar manner.

A partly obliterated raised roadway or terrace can be traced extending for a considerable distance in the direction of the Red Sea.

A peculiar feature of the district is the presence of a good many crudely formed obelisks, each consisting of a huge roughly hewn mass of stone, with somewhat smaller ones lying at the base. It is probable that these once had some significance, but with what intention they were erected none can decide, although some think they answered the purposes of signposts.

On the walls of some of the buildings, especially on those of the temples, inscriptions are to be seen. Those which have been deciphered, although of great interest, do not help to solve the riddle of the mines.

The interiors of the barrack-like buildings have walled-up recesses surmounted by slabs of stone slanting downwards from the apex. Immediately below the apex is invariably to be found a stone image of a god, placed there for some reason connected with the religion of the departed race.

It is difficult to imagine a more wild region than the country surrounding these emerald mines, and yet there is a majesty of beauty in the hideous bare mountains, through which meanders a graceful wâdy of rock and coarse sand at almost every turn. (See Figure 124.)

With the exception of here and there an isolated stunted tree, there is next to no vegetation. A few wandering Bedouin Arabs, ever in search of the water, which they rarely find, form the only inhabitants of this drear spot, which thousands of years ago must have echoed with the hum of busy slaves toiling to supply their rulers with a useless gewgaw.

Dr. Max Bauer, in "Precious Stones," states that gold and topaz are found in the range of mountains in which the emeralds occur.

For information and the photographs the writer is indebted to Mr. Edwin W. Streeter who pioneered an expedition in the mines, and to Mr. Allan Forster and Mr. F. Grote, two members of his party.

TROMBIDOIDEA.

By CHARLES D. SOAR, F.L.S., F.R.M.S.

NATURALISTS, particularly those naturalists who study the minute forms of animal life with the aid of the microscope, have not paid much attention to the British Acarina. Why the study of mites has been so much neglected in Britain cannot be for want of specimens, for they can be found almost anywhere. One reason may be on account of their minute size, and the trouble that has to be taken to find them. Another reason is, no doubt, the dearth of literature on the subject. As yet we have only two monographs on British mites, although there are a large number of papers distributed about in the different natural history and microscopical journals. There are several acarologists on the Continent who are doing some splendid work with the mites, but they are outside the Britannic area. Nevertheless, their papers are very useful for the description and identification of what mites we find here. The water mites found on the Continent are nearly all found here in the British Isles, so it will no doubt be the same with the land mites.

Except in the case of some of the families of the Sarcoptoidea and Ixodoidea, there is nothing repulsive about the study of mites, and they all exhibit a great variety of form and colour. Their life-history is only known in a few cases, but we know by experience what a great part they play in nature's economy. There is plenty of original work waiting to be done, and it would be worth doing. There are about thirty families of the Acarina waiting for their history to be studied and written in the British Isles. Two families have been done, and done well, the Oribatidae and the Tyroglyphidae, by Mr. Michael, F.L.S., both published by the Ray Society.

Let us just glance at the super-family Trombidoidea. This is divided into six families:—

First, Trombididae, commonly called harvest mites. The small, red, velvety mites we find on our garden borders belong to this family. All the mites of this family are red, some darker than others. The body is covered with feathered hairs, according to the species. A monograph on the Trombididae has just been published by A. Berlese. He has divided the family into fifteen genera, and gives a coloured figure of each type species. Dr. George, of Kirton-in-Lindsey, has published some papers in *The Naturalist* on these mites, but the subject is only begun as yet.

Second, Caeculidae. This is a small family of rather large mites, found in moss, fallen leaves, and moist places, rectangular in shape, and with very rough legs. They are found in Southern Europe, but I have not yet seen any record for Britain.

Third, Rhyncholophidae. Several species of this family have been recorded by Dr. George in *The Naturalist*, representing different genera. There was one particularly beautiful mite, with plumes on the fourth pair of legs. It is known as *Eatoniana plumifer*, and I think was found in Jersey. It is common in Southern Europe and North Africa. I think Dr. George's record is the only one for the British Isles.

Fourth, Cheyletidae. A small family of little mites. They are distinguished by the enormous palpi attached to a distinct beak. They are animal feeders, some predaceous, some parasitic, divided into about eight genera. Two or three species have been recorded for the Britannic area.

Fifth, Erythraeidae. Quite a small family, containing only four genera. They are red in colour, quick in their movements, and very erratic in their course.

Sixth, Tetranychidae. These are well known as the red spiders. Several have been recorded for Britain. They are divided into about eight or nine genera. The genus *Bryobia* appears to be the most common.

The super-family Trombidoidea is a large one, and represents with its six families a large number of genera, but it would well repay anyone to take up any single family and work it out.

XUM

THE DOUBLE (AND BINARY) STARS.

By F. W. HENKEL, B.A., F.R.A.S.

". . . . Other Suns, perhaps,
With their attendant moons, thou wilt descry
Communicating male and female light,
Which two great sexes animate the World,
Stored in each orb, perhaps with some that live."

—*Milton* ("Paradise Lost," VIII, 148–152).

THOUGH the Copernican hypothesis of the Earth's motion round the Sun was immensely strengthened by the discoveries of Galileo, and the Newtonian theory of gravitation supplied the *modus operandi* for this motion, yet the objection of the opponents of Copernicus that the stars do not *appear* to move as they should do in consequence of that motion, long remained a serious difficulty. "Were the Earth in motion in a mighty orbit round the Sun," said they, "spectators on our planet would, without difficulty observe displacements in the relative positions of the stars during the course of the year, the nearer stars moving more and the more distant ones less, just as objects in the surrounding landscape appear to move when seen by a spectator in a moving carriage." But no such motions could be detected, and all that could be answered was that the distances of the stars are so vast that the size of the Earth's orbit is but an insignificant quantity in comparison. It was no doubt partly on account of his difficulty in accepting this explanation that Tycho Brahé was led to reject the Copernican views, since his observations had not enabled him to detect any "parallactic" change of place due to the Earth's supposed motion, and his measurements of the apparent diameters of the stars had led him to conclude that the brightest of these objects would be of enormous dimensions (greater than the whole Earth's orbit) were the Copernican hypothesis true. After the invention of the telescope it was seen that the apparent diameters of the stars were very much less than had been assumed to be the case by Tycho and others and up to the present time the true diameter of a star has never been measured, being less than the *minimum visible*, the disc seen by the naked eye being an optical illusion, an effect of irradiation.

Galileo, in one of his "Dialogues on the Systems of the World," proposed that pairs of stars seen close together in the sky should be observed and their relative position noted and distance measured throughout the year. If one of these objects be nearer to us than the other, it will be displaced and the angles and distances will change regularly in that interval of time. The same idea was suggested by others, but the first to carry out the suggestion systematically was Sir William Herschel. The latter, finding many cases where two or sometimes more stars lie close together in the sky, and supposing the brighter component was nearer to our system than the fainter one, made numerous measurements, expecting to find regular annual variations due to this supposed difference of distance—in other words, parallactic displacement.* But instead of finding this Herschel detected a regular progressive change of quite a different nature, showing sometimes that one of these bodies was describing an orbit round the other, or that both were travelling together throughout space. In his own words he "went out like Saul to seek his father's asses, and found a kingdom"—the existence of systems (of Stars) of a different and higher order from that prevailing in our own system, binary and multiple stars. A distinction was thus made between stars optically connected which merely lie nearly in the same direction, as seen from our planet, but may be as far removed from one another as they severally are from our system, and stars physically connected—systems consisting of two or more members moving round a common centre, or in nearly parallel paths in a common direction. All over the sky there are to be found cases of two or more stars lying much closer together than the average distances of the stars from one another, and perhaps as many as twelve thousand such couples are known, the *double stars*. Some of these doubles have components of nearly equal brightness (e.g., the two components of α Centauri, the nearest of all external celestial objects to our system, so far as is yet known, and the two components of 61 Cygni, the next nearest system—both of these are also *binaries*); in other cases the members are of very unequal magnitudes, like Sirius and its companion, the former being the brightest of all the stars visible to us, whilst the latter is only visible by the help of the most powerful telescope, and was not detected till 1862. In that year the late Alvan Clark first saw it with the recently finished Chicago refractor, the then largest instrument of its kind in the world. Several hundred binary systems are now known with more or less certainty, moving in elliptic orbits round common centres, the orbits in some cases being almost circular, in others very oval and "eccentric." There are also systems of three or more stars, the trinary and multiple stars. The star ζ Cancri consists of two larger and fairly close members revolving in nearly circular orbits round

* Parallax is the name given to an apparent displacement of an object due to a real displacement of the position of the observer. Technically, the parallax of a star is the angular value of the semi-diameter of the Earth's orbit (which is greater as the star is nearer), as seen from the star.

their common "centre of gravity," with a third fainter and more remote body, whilst ϵ Lyrae consists of two pairs of stars, and the multiple star θ Orionis, not far from the centre of the great Nebula, consists of four principal stars and two minute companions very close to two of the brighter, "to perceive *both* which is one of the severest tests which can be applied to a telescope" (Sir John Herschel), but three of the four brighter were detected by Huyghens, in 1656. Though, as we have just seen, the number of double stars known to modern astronomers, and visible through the telescope, is thus considerable, yet the angular distance of the components is too small to admit of their detection by the unaided eye in pre-telescopic days, so that though a few clusters were known to the ancients, the first double star which attracted attention seems to have been ζ Ursae Majoris, Mizar in the Great Bear, which was noted as double by Riccioli about the middle of the seventeenth century (Lewis). This was also the first star to be photographed as double, by G. P. Bond, in 1857, and also the first "spectroscopic binary," a class of objects of which we shall hear more later on. It is curious, too, that there is comparatively close to Mizar, which is of the second magnitude, a faint star, Alcor, just visible to the unaided eye, and it is said that the Arabs considered its detection as a test for keen eyesight. This star is said to be sometimes known as "Jack by the Middle Horse," Mizar being thus the "Middle Horse" pulling "Charles' Wain." Dr. Hooke, in 1665, discovered that γ Arietis consisted of two fourth-magnitude stars, eight seconds of arc apart. During the eighteenth century the well-known doubles, α Centauri, γ Virginis, Castor, 61 Cygni, β Cygni, ϵ Lyrae, α Herculis, and ζ Cancri were added to the list. The latter star was discovered by Christian Mayer, a Jesuit priest living at Mannheim, and shortly before his death, in 1781, he published a catalogue of all double stars known up to that date, including his own additions, making a total of eighty-nine pairs. For the first time he hazarded the suggestion that some at least of these pairs must be physically connected, a suggestion fully confirmed a few years later. As already mentioned, when first discovering and observing hitherto unknown double stars, Herschel hoped to employ them to determine parallaxes, but continued the work with other ends in view. His first catalogue contained two hundred and sixty-nine pairs, and its examination by the well-known philosophical writer, the Rev. John Michell, the "ingenious Mr. Michell" as he is called by Mr. Lewis, led him to make the following remarks. He says: "The very great numbers of stars that have been observed to be double by Mr. Herschel, if we apply the doctrine of chances, cannot leave a doubt with anyone that by far the greatest part, if not all, of them are systems of stars so near to each other as probably to be liable to be affected sensibly by their mutual gravitation, and it is, therefore, not unlikely that the periods of some of these about their principals (the smaller ones being upon this hypothesis considered as satellites to the others) may some time or other be discovered." We may assent to the conclusions, or rather to the probable meaning of their author, without committing ourselves to approval of his language. It was not, however, till 1803 that Herschel made the definite statement that some of these combinations were indeed binary, in a paper which he contributed to the *Philosophical Transactions* of the Royal Society. This he justified by his examination of the measures of *Castor*, *γ Leonis*, *γ Virginis*, *δ Serpentis*, and *ϵ Boötis*. Of seven hundred and two double stars contained in Herschel's two catalogues, the members were divided into six classes according to their angular distance apart.

Class I	contained	97	pairs	separated less than 4″.
Class II	„	102	„	„ from 4″ to 8″.
Class III	„	114	„	„ „ 8″ to 16″.
Class IV	„	132	„	„ „ 16″ to 32″.
Class V	„	137	„	„ „ 32″ to 60″ (1′).
Class VI	„	121	„	„ over 60″.

Since Herschel's day the whole subject of double-star astronomy has been vastly extended, and our knowledge greatly increased by the labours of a host of professional and amateur workers. Amongst the foremost of these must be placed the name of F. G. W. Struve, of Dorpat, whose classic work, familiarly known as the "Mensurae Micrometricae," still remains the standard authority "for method and arrangement." This catalogue, published in 1837, contains measures of two thousand six hundred and forty pairs of stars, three fourths of the ten thousand four hundred and forty-eight measures being made by Struve himself without assistance, but during the latter part of his work he had the assistance of his son and other observatory assistants, "who entered the readings and turned the dome, but made no measures." These measures have been collected, compared and discussed with much other information relating to double stars in a volume by Mr. Thomas Lewis, F.R.A.S., of the Royal Observatory, Greenwich, published in 1906 (*Memoirs of the Royal Astronomical Society*, Vol. LVI). Struve's work comprised a general survey of the sky between the North Pole and 15°·5 declination, about 0·63 of the whole sky. His plan of work was (1) to discover and catalogue double stars; (2) to make micrometer measures of them; (3) to estimate the magnitude and note the colours; (4) to fix the places by meridian observations. Between February 11th, 1825, and February 11th, 1827, he examined one hundred and twenty thousand stars from the first to the third magnitude, and found three thousand one hundred and twelve double stars, whose distance apart did not exceed 32″.

Many of the double stars exhibit the remarkable phenomenon of contrasted colours, but it has been remarked (Proctor, "Old and New Astronomy," p. 783) that this is never the case when the two

adjacent stars are of nearly equal magnitudes, and it appears to be the universal rule that when there is a contrast of colour the tint of the fainter star lies more towards the violet (more refrangible) end of the spectrum than that of the other. Thus, the brighter star being reddish or yellowish will have a green or blue companion. Sir John Herschel, who worthily continued his father's work, and also contributed what he modestly calls his "mite" towards double-star astronomy, has suggested that this complementary colouration is "probably in virtue of that general law of optics that when the retina is under the influence of excitement by any bright light, feebler lights, which when seen alone would produce no sensation but of whiteness, shall for the time appear coloured with the tint complementary to that of the brighter." There are, however, difficulties in the way of accepting this explanation in all cases, and others are inclined to regard this contrast of colours as being, in some cases at least, due to a real difference in the physical nature of the stars. However this may be, the beauty of the sights visible to the telescopist is greatly enhanced by the wonderful display of colours given by different celestial objects. It is often found that if in a double-star system the coloured star be much less bright than the other, it will not affect the latter's colour. Thus, for example, η Cassiopeiae is composed of a large white star and a fainter one of a "rich ruddy purple." A pleasing picture of the curious alternations of illumination that would be produced for the inhabitants of a planet circulating round a pair of coloured double stars may be drawn, and is given by Sir John Herschel ("Outlines of Astronomy," p. 851). Suppose a planet revolving round a red and and green sun. When the red sun rises there will be daylight, and "all will be red." Bye and bye the green sun will rise and mount higher above the horizon. The light will gradually change from a reddish tint to pure white. Later on, the red sun will set, and the remaining illumination will consequently be green. Last of all, the green sun will set, and darkness will set in. Thus we have the alternations red-day, white-day, green-day, and night, the colours of all objects undergoing corresponding variations.

It is a remarkable fact that though isolated red stars are found in most parts of the sky, no decided green or blue star has ever been noticed unassociated with a brighter companion (Herschel).

We have already stated that the orbits of binary stars round their centre of mass are ellipses, usually much more oval than the planetary orbits in our solar system, the average eccentricity of the visual binaries being about 0·5 (See "Researches," Vol. II, ch. 20), but it is a remarkable and interesting fact that the closer "spectroscopic" binaries move in much more nearly circular orbits. The application of the spectroscope to stellar astronomy has not only given us information otherwise unobtainable as to the chemical nature of the heavenly bodies, but it has also enabled us to detect hitherto unsuspected motions, and has rendered known the existence of bodies perhaps for ever invisible to our telescopes. By means of this instrument it has been ascertained that the number of binary stars is far greater than anyone had previously imagined, but that in most cases the components are too near together to be separated by the most powerful telescope. According to estimates based on the work done at the Lick Observatory, Campbell found that about one star in five of those examined proved to be a spectroscopic binary, and in certain groups this ratio was found by Frost to be as high as one third (See). The telescope discloses only the widely-separated and luminous companions amongst the systems nearest to us in space, but the spectroscope enables us to detect all attendant masses which are large enough perceptibly to disturb their luminous "fellows," whatever be their distances, thus enormously increasing our knowledge of stellar systems. When a star is approaching us the dark and bright lines in its spectrum are shifted slightly towards the violet; when it is receding they are shifted in the opposite direction, and by the comparison of well-known lines thus changed in position with their ordinary position as seen in terrestrial spectra it is possible to determine the speed of their motion. Thus, the well-known variable star, Algol, exhibits changes in its spectrum indicating that the velocity in the line of sight undergoes variations, being alternately towards and away from the Earth, and thus is confirmed the view that its variability is due to partial eclipse by a revolving dark satellite, the "stupendous dark globe." It has been shown, too, that α Virginis, like Algol, has a massive dark companion which, however, does not eclipse, as it does not come between the star and our position. Other double stars have been discovered in which both components are bright, so that at one part of their orbit the lines common to the spectra of the two stars appear double and separated, gradually closing up till they appear single and then opening out once more. Since visual binaries with known orbits are found to give variations of a similar character in their spectra and have thus come to be included in the class of spectroscopic binaries as well as "visual" ones, but so far no spectroscopic binaries first discovered as such have been resolved telescopically, we see that the difference merely consists in the smaller size of their orbits and consequent shorter periodic times of revolution of the latter. Periods of a few days, or even hours, are known for these, whilst the shortest periods for a visual binary yet known is that of δ Equulei (5·7 years) and orbits with periodic times of hundreds of years have been calculated for some of the more widely-separated binaries (γ Virginis, 182 years; σ Coronae, 340 years, Lewis). When the angular dimensions of the orbit and the parallax of the system are known, the real dimensions (in miles, kilometres, and so on) are easily calculable, and from a knowledge of the

periodic time of revolution the total mass of a binary system may be obtained from the extension of Kepler's third law, assuming the motion due to an action of a gravitative character. Let M_1 and M_2 be the masses of the two components respectively, M and m the mass of the Sun and Earth.

Then $$M_1 + M_2 = \frac{a^3}{R^3} \frac{T^2}{p^2} (M + m)$$

where T = Earth's period of revolution = 1 year and R = the semi-axis major of its orbit, the astronomical unit; a and p being the semi-axis and periodic time respectively of the stellar system. Thus our formula becomes

$$M_1 + M_2 = \frac{a^3}{p^2}$$

giving the mass of the system in terms of the Sun's mass as unity.* Thus we find the masses of many of the binary systems are comparable with that of the Sun, some being rather smaller, others considerably greater.

Of fifty-three orbits of spectroscopic binaries dealt with by Dr. See, he finds that the mean eccentricity of these orbits is considerably less than that of the visual binaries, being only 0·23 instead of 0·5, as for the latter, a point which has important bearings on Cosmogonic theory. The average period for these fifty-three systems is about thirty-seven days, but if we exclude a few long period stars, the average period of all the rest is about ten days. From the formula

$$M_1 + M_2 = \frac{a^3}{p^2}$$

assuming the average mass of the spectroscopic binaries to be about the same as that of the visual ones, and taking $M_1 + M_2 = 1$, we find the average value of the mean distance to be 0·2173 astronomical units, when $p = 37$ days or 0·09 when $p = 10$ days. Thus the average dimensions of these orbits are less than that of the planet Mercury, and it seems probable that for such orbits the efficacy of tidal friction as a possible agency in changing their forms may not be overlooked. The late Sir George Darwin, whose recent death we have to deplore, and whose researches on the problems of fluid motion and tidal friction generally are well known, was of opinion that many double stars have been generated by the division of primitive and more diffuse single stars, in a manner somewhat analogous to that in which he supposed that our own Moon came into being. Many difficulties, not altogether ignored by Darwin himself, prevent our acceptance of his views as regards the origin of our satellite, but there appears more reason to consider that the fission theory of the origin of double stars is a true one. Such fission would give rise to nearly circular orbits, and though this is not the case with the known systems, it is more true for the nearer spectroscopic binaries than for the more widely separated visual ones. But it has been shown that when two bodies of not very unequal masses revolve round one another in close proximity the conditions are such as to make tidal friction as efficient as possible in transforming the orbits. Hence we have in tidal friction a cause which may have not only sufficed to separate the two component stars of a double star system from one another, but also to render the orbit eccentric (Darwin). Thus it may be that under this influence in the course of time the orbits of the spectroscopic binaries will increase and become more eccentric, more nearly like those of the "visual" binaries. On the other hand, it is not impossible that some of these orbits may be shortening and becoming more nearly circular under the action of the resisting medium, whose long-continued action affords the best explanation yet advanced of the comparative circularity of the orbits of the planets in our own Solar system. The efficacy of tidal friction (whose tendency is to produce increase of eccentricity and distance) is greater as the mass-ratios of the bodies acting and acted upon are more nearly equal, as in the components of a double star system, and least when one mass greatly preponderates, as in our own Solar system, where the mass of the Sun exceeds that of all the planets put together more than six hundred times. "The preponderance of high eccentricities amongst the equal pairs seems to be an indication of the higher efficacy of tidal friction, or of the lesser importance of the action of a resisting medium in such systems," and so, whilst deducing one confirmation of the action of tidal friction and the resisting medium from the small size and roundness of the orbits of the spectroscopic binaries, we may find an additional verification of this theory in the larger eccentricities occurring amongst binary stars with nearly equal components. We may, too, if we please, derive important conclusions as to the relative ages of the various systems. Thus from the theoretical researches of Sir G. Darwin on tidal friction, supplemented by the long imperfectly recognised agency of the resisting medium, Professor See has for the first time succeeded in giving a reasonable account of many remarkable features in the phenomena of the starry heavens, and has securely laid the foundations and much of the superstructure of a rational cosmogony. But there will always remain "the immeasurable magnitude of the undiscovered" to humble our pride; and ever upward progress, we trust, in our knowledge of the wondrous universe of God, will not lead us to imagine that we have "solved the universe."

* The Earth's mass being only $\frac{1}{330000}$ that of the Sun, is here neglected.

XUM

SOME NOTES ON THE ANIMAL LIFE OF BLAKENEY POINT.

By WILLIAM ROWAN.

BLAKENEY POINT needs no further description after Mr. Grew's article in the January issue of this Journal. One might repeat again, however, that "the Point" is the extremity of a shingle spit, some eight miles in length. It is separated from the mainland by the "Blakeney Channel," and is a sail, at high tide, of over a mile from Morston.

FIGURE 132. The Lesser Tern.

The birds being the most noticeable feature of the animal life, we are describing them first. As might be expected, few of the species found in the summer are found in the winter, while in the autumn and spring many rare migratory birds pay a fleeting visit.

Should you visit the Point in summer, you would notice that as you approach it birds rapidly get more numerous. They all appear to be of one kind —the common tern (see Figure 133).

FIGURE 133. The Common Tern.

If you are an ornithologist, however, you will soon notice that mingled with these is a considerable sprinkling of the lesser tern. They are fishing all around, and time after time you see a bird dive into the water, rise with a little fish in its beak, and disappear over the dunes. They all seem to go in the same direction, and even when the shoal of fry, on which they are feeding, has gone out with the tide you notice stragglers making their way over the dunes. If your interest has been sufficiently aroused, you also take the same road on landing. As you climb up the side of the dunes all is quiet. You may put up a dotterel with her little chicks, or bolt a rabbit, but that is all. But as you reach the crest, and catch a first glimpse of a long shingly beach, with the open sea beyond, a cloud of birds rises in the air. The noise is terrific, and as you climb down the other side to get a nearer look, and walk underneath the great whirling mass, one bird after another with an earsplitting shriek makes a desperate swoop at your head. It is merely show, however, and you need fear no injury.

And so you have made the acquaintance of the noisiest and most important inhabitants of the Point. Their nests are strewn all over the shingle on the seaward side of the dunes. If your visit be in July, you will see many young already running about. They almost invariably crouch when you approach, and are often hard to see. Apart from their size, their black chin distinguishes them at once from the young of the lesser tern (see Figure 132). The eggs vary enormously in size, ground colour and markings. Eggs at the two extremes of the scale are often found in the same clutch. About the use of material for nest-building there seems to be no definite law. As a rule, materials are used when they are handy, and only when they are. For instance, of all the nests examined last summer on the drift line, in only one case had the birds deposited their eggs without collecting material on which to lay them. In one case the "nest" was eighteen inches across. On the open shingle one must be constantly on the *qui vive* to avoid stepping on to the eggs.

In the centre of the colony you will find nothing but the eggs and young of the common tern. The birds resent the intrusion of any stranger in a practical way. Even the rabbits have to keep clear of those dunes that the terns occupy. On the outskirts of the colony you will, however, find the lesser tern. The nests of this bird are not crowded together like those of the former, and you will only find them on the Point in one kind of shingle, composed of very small stones and sand. This is in the main found immediately above and below the highest tide limit,

so that in certain years, as in 1911, when there was an exceptionally high tide in the end of June, hardly a young bird was hatched out. That year the colony consisted of some sixty pairs, or probably more. The lesser tern is almost as bold as its larger relative. The male is generally supposed not to incubate the eggs. Figure 132, however, shows him in the act, with his wife waiting for her turn. Three is usually stated to be the average number of eggs, but some forty-five nests examined the maximum number found was two.

FIGURE 134. The Ringed Plover.

Another bird found nesting in some numbers, though it lays earlier than the terns, and is resident the year round, is the little ringed plover (see Figure 134). You find its eggs chiefly behind the dunes (see Figure 135), and in small sheltered lows. The birds seem to object to the exposed shingle. They are extremely shy, and to secure a photograph of one needs the exercise of considerable patience. Other birds that are found nesting are larks, pipits, wagtails, red-legged partridge, sheld-duck and one pair of oyster catchers. Last year, for the first time, there were two.

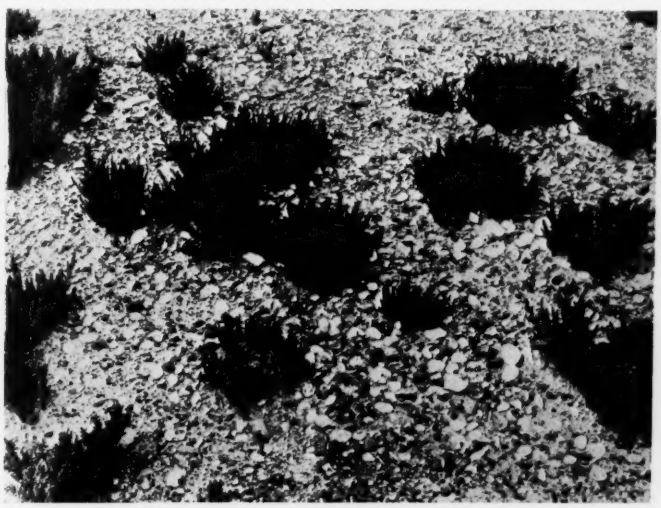

FIGURE 135. Eggs of the Ringed Plover.

All the common gulls are well represented, though none nest. Other sea birds pay short visits throughout the summer.

Should your visit fall in the winter months, you would find the Point very different. With the exception of a few gulls flapping over lazily from the mainland, no birds come near the boat as you cross. When you have landed you find that the shingle, so noisy and full of life in the summer, is now deserted and the marshes are the scene of activity. Should you hide and watch them with a pair of binoculars, you will soon notice that the waders predominate. The commoner species are curlew, dunlin, sanderling and ringed plover, with an occasional redshank, while knot occur in vast flocks, sometimes numbering over one thousand. Larks and linnets feed in the marshes in great numbers. The gulls, again, are well represented on the beach, though now may be seen an occasional huge glaucous gull. If the winter be a severe one, however, the bird life is swelled by a huge army of ducks and geese. Among the former, widgeon, mallard and sheld are the commoner. Among the latter, brent, pink-feet and barnacles. In the late autumn the swan is not an uncommon sight, while the great northern black-throated divers are of regular occurrence.

Of the mammals, the rabbits are by far the most numerous. In summer time, when the long evenings draw gently to a close, the Point seems to swarm with them. Old and young are all out then, taking their supper in the marshes or on their moss-grown margins. As you stroll quietly along between these and the dunes, one rabbit after another bolts across your path, heading for safety to its burrow. If you turn off now to the side, and make for the marsh, many more bolt past you, till you reach their feeding ground. The first thing that catches your eye is their well-marked runs, reaching right away to where the tide is softly creeping up (see Figure 137). Everywhere you see *Aster tripolium* eaten. Its succulent leaves are not as salt as one might imagine. On the edges the Suaeda bushes are also bitten, in some cases to the ground. Still further in, towards the dunes, *Convolvulus soldanella*, covering large areas of the firmer ground, is also badly attacked.

On the crest and seaward side of the dunes are a few burrows, but they are a mere sprinkling compared with those on the other side.

Were it not for numerous tracks, one would at first suppose in winter time that the rabbits had gone, for you see none of them. Day breaks at

about seven or soon after, and it is certain that there are no rabbits about then. But if you search carefully, you will find many tracks, freshly made; for the rabbits have been out earlier than you. In the

FIGURE 136. Glaux Lagoon.

evenings, too, they only come out after dark, when you have made yourself comfortable in your tent. Their food remains much the same now as in the summer. One interesting addition to the list must be mentioned, however. In the Glaux lagoon (see Figure 136), now filled with water, there are considerable patches of sand dug up by rabbits. They are plainly seen on this photograph, showing up dark. It was some time before the cause of this nightly exercise was found, but it eventually proved to be that the rabbits dug up the ground to reach the Glaux rhizomes for eating.

Rats are, unfortunately, quite abundant on the Point. Since the stranding of a whale on the beach, in the fall of 1910, they have been there. In 1911, they were present in such numbers and harrassed the terns so seriously, that these laid an extraordinary number of mis-coloured and mis-shapen eggs. Since then poison and traps have been kept on the go incessantly, but still they are there. This winter their tracks were wonderfully abundant round the tents. They live chiefly in the rabbit burrows.

As harmful as the rats are the two small colonies of stoats, which are now, however, almost at the point of extinction.

At least one kind of vole occurs, and as casual

FIGURE 137. Rabbit runs in salt marsh.

visitors seals must not be forgotten, for they often turn up and spend a few days on the Point. As many as seven have been seen at the same time.

THE ROYAL INSTITUTION.

A GENERAL MEETING of the Members of the Royal Institution was held on the afternoon of March 3rd, Sir James Crichton-Browne, Treasurer and Vice-President, in the chair. Mr. T. W. E. Davenall, Mr. P. M. Deneke, Mr. H. Trevelyan George, Mr. H. G. Gillespie, Mr. W. V. Graham, Lady Heath, The Hon. Marguerite de Fontaine Drever Joicey, Mr. J. A. Law, Rev. J. Marchant, Dr. W. A. Milligan, Mr. D. W. Moncur, The Hon. Mrs. R. Parker, Mrs. Carson Roberts, and Miss Tatlock, were elected Members. The Honorary Secretary announced the decease of The Right Hon. The Earl of Crawford, Mr. George Matthey, and Sir William H. White, Members of the Royal Institution, and Resolutions of condolence with the relatives were passed.

The following are the Lecture Arrangements at the Royal Institution, after Easter:—Dr. A. S. Woodward, Two Lectures on Recent Discoveries of Early Man. Professor W. Bateson, Fullerian Professor of Physiology, Two Lectures in continuation of his before Easter course on The Heredity of Sex and some Cognate Problems. Professor W. Stirling, Three Lectures on Recent Physiological Inquiries: 1, Protective and other Reflex Acts; 2, Equilibrium and the Sixth Sense; 3, Ductless Glands and their Dominating Influence. Professor T. B. Wood, Three Lectures on Recent Advances in the Production and Utilization of Wheat in England. Dr. E. Frankland Armstrong, Two Lectures on 1, The Bridge into Life; 2, Colour in Flowers. Professor J. Garstang, Three Lectures on The Progress of Hittite Studies: 1, Recent Explorations; 2, Religious Monuments of Asia Minor; 3, Cults of Northern Syria. Mr. Edward Armstrong, Two Lectures on Florentine Tragedies: 1, The Exile of Dante; 2, The Burning of Savonarola. Professor W. J. Pope, Three Lectures on Recent Chemical Advances: 1, Molecular Architecture; 2, Chemistry in Space; 3, The Structure of Crystals. Mr. A. M. Hind, two Lectures on 1, Van Dyck and the Great Etchers and Engravers of Portrait; 2, Rembrandt's Etchings. Professor Sir Walter Raleigh, three lectures on 1, Boccaccio; 2, Mediæval French Novelists; 3, Chaucer. Mr. H. A. Humphrey, two lectures on Humphrey Internal Combustion Pumps. Professor E. Rutherford, three lectures on Radio-activity: 1, The Alpha Rays and their connection with the Transformations; 2, The Origin of the Beta and Gamma Rays and the connection between them; 3, The Radio-Active State of the Earth and Atmosphere. The Friday Evening Meetings will be resumed on April 4, when Mr. James J. Dobbie will deliver a Discourse on The Spectroscope in Organic Chemistry. Succeeding Discourses will probably be given by Mr. C. J. P. Cave, Dr. T. M. Lowry, Professor J. Garstang, Mr. H. G. Plimmer, and other gentlemen.

THE INFLUENCE OF AGE ON THE VITALITY AND CHEMICAL COMPOSITION OF THE WHEAT BERRY.

By R. WHYMPER.

(*Continued from page 90.*)

TABLE 23.

ANALYSES OF SOME OLD SAMPLES OF WHEAT.

	Mummy Wheat Estim. 1500 B.C.	Rothamsted Wheat.			Rivet Wheat, 1911.
		1852	1853	1854	
	%	%	%	%	%
Moisture	10·69	16·54	8·32	12·68	12·10
Ash	0·68	0·90	0·83	1·14	2·04
Fat or Ether Extract ...	1·71	2·98	1·83	1·66	2·51
Nitrogen ...	1·686	1·799	1·915	1·549	2·023
Proteid (Nx 6·25)	10·54	11·24	12·12	9·67	12·64
Soluble Carbo-hydrates ...	3·68	3·46	5·16	5·16	4·04
Starch	68·18	60·0	68·72	66·13	66·24
Husk or Fibre ...	1·50	1·62	1·70	1·61	1·78
Acidity (taking the 1911 sample as Unity) ...	2·6	1·1	0·7	1·6	1·0

the various ages examined, the moisture content should show considerable fluctuation.

Ash.

Just as moisture in wheat and flour is a variable according to the conditions of storage, so may also the ash content of wheat be found to vary according to the soil in which it is grown.

Wheat as a general rule varies in ash content from two per cent. to about one per cent, below which it is extremely unlikely to fall.

It is, therefore, of considerable interest to notice that there is a gradual decrease in mineral matter with age, with the exception of the 1853 wheat which contains a slightly higher quantity than that of 1854, and which, in other particulars does not seem to fall into line with the wheats according to its age.

Snyder (*Bull. 85 Agric. Expt. Stn. Univ. Minnesota, 1904*) found that the percentage amount of ash in different wheat crops varies but little from year to year, and that flour made from fully matured wheat has a minimum ash content because high maturity is usually accompanied by a low ash.

This fact is forcibly borne out by the results obtained with the wheats of different ages examined by the present writer.

TABLE 24. COMPOSITION OF FLOURS AND OTHER MILLING PRODUCTS OF WHEAT.*

Milling Product.	Water.	Proteid Nx 5·7.	Fat.	Carbo-hydrates.	Ash.	Acidity (taking the wheat ground in the Laboratory as Unity.	Nitrogen.
							%
First Patent Flour	10·55	11·08	1·15	76·85	0·37	0·44	1·9435
Second Patent Flour	10·49	11·14	1·20	76·75	0·42	0·44	1·9544
Straight or Standard Patent Flour	10·54	11·99	1·61	75·36	0·50	0·50	2·103
First Clear Grade	10·13	13·74	2·20	73·13	0·80	0·67	2·410
Second Clear Grade	10·08	15·03	3·77	69·37	1·75	1·50	2·636
"Red Dog" Flour	9·17	18·98	7·00	61·37	3·48	3·27	3·33
Shorts	8·73	14·87	6·37	65·47	4·56	0·72	2·608
Bran	9·99	14·02	4·39	65·54	6·06	1·27	2·459
Entire Wheat Flour	10·81	12·26	2·24	73·67	1·02	1·72	2·150
Graham Flour	8·61	12·65	2·44	74·58	1·72	1·00	2·219
Wheat ground in Laboratory ...	8·50	12·65	2·36	74·69	1·80	1·00	2·219

CHEMICAL EXAMINATION.

Moisture.

The percentage of moisture found in wheat is a very variable quantity. In a personal letter from Mr. Humphries the figures for English wheat grown last year were given, and showed on an average fourteen per cent of moisture in October, 1911. In February, 1912, the moisture content had risen to eighteen per cent., and in June, had fallen to approximately sixteen per cent. Similar experience has of course been the lot of every miller, and therefore it is not surprising to find that, in the wheats of

Fat or Ether-extract.

A specially dried Ether was prepared for these estimations and the figures may be taken as those of actual fatty matters extracted.

*Studies of Bread and Bread-making at the University of Minnesota in 1899–1900, by Harry Snyder, B.S., Washington, 1901.

XUM

It was with considerable surprise that 1·71 per cent. of Ether-extract was taken from the Mummy Wheat when compared with 2·51 per cent. from an English wheat harvested in 1911. The figures have, however, been carefully checked and confirmed.

Wheat oil very rapidly undergoes decomposition on exposure to air, De Negri finding that a sample after being kept for one year contained nearly half its weight of free fatty acid calculated as Oleic acid.

Balland (*Compt. Rend.* 1903, CXXXVI, 724) obtained some sixteen parts of Ether-soluble fatty acids with eighty-four parts of true oil from one hundred parts of fatty matter extracted by Ether from freshly-milled flour, whilst an older sample of flour gave fatty matters containing only eighteen per cent. of true oil with eighty-two per cent. of mixed fatty acids.

It is apparent, therefore, that quite a large proportion of the fatty acids obtained from wheat oil is soluble in Ether, a fact which accounts for the unexpectedly high figures obtained for fatty matter extracted by Ether from the Mummy Wheat.

There may also be a small quantity of bitumen included in the Ether-extract from Mummy Wheat.

Nitrogen and Proteid Matter.

The quantitative changes which the wheat has suffered during storage are comparatively insignificant, and such differences as are found may be said to fall within the limits for normal wheats of different varieties.

The nature of the changes undergone by the proteid matter, however, is striking in the case of the oldest wheat but quite unworthy of consideration of those grains up to fifty years of age, as has already been shown when the gluten strength of the crushed wheats under examination was discussed.

The process of decomposition of the wheat gluten is mainly biological, in that bacteria play a very important part both in oxidising the actual nitrogenous matter and in producing acids from the other components of the grain capable of degrading the gluten.

It is certain that under normal atmospheric and humidity conditions neither bacteria nor fungi could obtain a good hold on the wheat berry, but that, after the passage of a number of years, when the outer protective covering of the grain had itself become oxidised and permeable, the process of decomposition would proceed more rapidly within the grain.

The period of time necessary to bring about these internal changes is entirely dependent upon the conditions under which the wheat was stored.

There are other factors which have been shown by various experimenters to have marked effect on the physical characteristics of gluten, and which may be more or less responsible for the reduction in the gluten strength of the flour obtained from the Mummy Wheat.

The degrading effect of acids has already been mentioned, and the results obtained by Snyder would prove that a flour of higher acidity is less efficient for bread-making, owing to a lack of strength which results from a pronounced decrease in gliadin percentage.

The differences of opinion between Snyder and Wood and others are mainly as to which is "the cause" and which is "the effect" of acidity; though, for the purposes required here, it is sufficient to notice that with increase of age there is greater acidity, and, in the extreme case, a complete loss of gluten strength.

The influence of mineral salts on gluten strength determined by Wood is of great interest to the baker and miller and in cases where the flour is made into dough with water. The general action of salts is that of coagulation or binding and toughening the dough, and often overcomes the degrading influence of an acid when both salt and acid are present.

Lactic acid of all strengths was found by Wood to reduce the wheat gluten strength, and that proportional increases in the quantity of added salt to procure cohesion of the dough were then necessary.

In the case of a normally air-dried whole wheat, however, the circumstances are different, and, with the exception of the mineral matter held in immediate juxtaposition to the proteid matter, the salt solutions can have little effect seeing that, under fairly constant conditions of temperature and humidity, "flow" does not exist to any extent and that such effect as is produced is purely local.

In the process of time the action of the self-contained salts may have effect on the gluten, and it is clear from the results obtained by the present writer that sixty years is, under normal conditions, too short a period to allow any appreciable degradation of gluten to take place within the wheat berry. This may be explained by the fact that the salt content of the newer wheats is still high enough to counteract the degrading effects of the acids as they form, and that, as age increases and the salt content of the berry falls, the full influence of the accumulating acids gradually becomes more apparent.

Carbohydrates—Soluble—and Starch.

The slight decrease in the Soluble-carbohydrates with increase of age is noticeable though without importance, whilst the starch content of all the wheats examined is constant within the limits of experiment and natural variations when the differences of moisture and proteid matter are taken into account.

The starch and fibre are undoubtedly the most stable of all the components of wheat, and the granules of starch from even the oldest samples do not show pitting due to enzymic action, a fact which adds further proof to the suggestion that the flow of solution within the berry was restricted, owing to lack of moisture.

Husk and Fibre.

The percentage of husk and fibre is practically constant in all the samples of wheat examined.

In the case of the Mummy Wheat the fibrous nature was completely lost and the friable powder resulting from the crushed husk was as though the berries had been roasted.

Acidity.

The acidity of the samples has already been fully discussed under former headings.

Diastatic Power.

With the exception of that from the newest wheat the aqueous extracts of all the samples examined failed to render starch soluble. It should be of importance to determine the connection between "loss of vitality" and "diastatic power."

In a letter from Mr. Humphries it is stated that wheat more than fifteen months old is rarely used in commerce, and, consequently, the changes which have been found to take place within the berry after a period of fifty or more years are not likely to be encountered by the practical miller.

The chemical and physical alterations which take place within the wheat grain, however, are the same, only to a much more retarded extent, as those which flour undergoes during storage, and they may, therefore, be taken as a guide for the latter purpose.

Flour improves, in most respects, from the bread-making point of view over a period extending for about two months, but beyond this limit there will be a deterioration, more or less rapid according to the quality and conditions of the flour and the conditions of storage.

Evaporation of moisture will be in proportion to the amount of heat occurring during storage, and the giving out and taking in of moisture are the prime factors which influence the changes, biological and chemical, which take place within the flour.

Balland (*Compt. Rend.* CXIX, 565) found the variations in chemical composition of flour during storage, for a range of over two thousand samples, to be principally due to fluctuations in moisture content, which reached a maximum in February of about 16·2 per cent., and a minimum in August of 9·40 per cent. The lowest percentage of acid was found by the same author to be 0·013 per cent. in January. while samples drawn in August contained nearly three times that amount.

Humphries, in his researches on the conditioning of wheat (*Brit. Assoc.*, 1911), points out that the mere addition of moisture to Southern Plate wheat was not sufficient to produce a marked change on the baking qualities of the resulting flour (this flour contained fourteen and a half per cent. of moisture), but that great improvement was noticed if the flour was also conditioned by addition of further water until it contained fifteen and a half per cent. of water.

Humphries observed that the improved flour showed a marked diminution in acidity (a statement certainly not in accord with expected results, unless the additional percentage of moisture had not been taken into account), and a decrease in the percentage of ash.

The production of inorganic phosphate by the addition of water was believed to be the chief cause of improvement.

In the light of Wood's experiments on the influence of salts on gluten, the perpetual though slow passage of a saline solution, such as that of a phosphate, through the cells of the wheat berry or in flour during storage, would undoubtedly tend to retard the degradation of the gluten, which we find to have taken place only in the most ancient wheats and which is principally due to the formation of acid, and to improve the gluten of a flour by increasing the ratio of conditioning salt to degrading acid.

The moisture content is the greatest variable, whilst acidity always increases with age, the period of time taken to produce absolute "inefficiency" of the gluten being greatly retarded by the presence of salts.

The passing of the moisture in and out of the flour or grain makes it possible for these changes to take place, and the extent of the alternations determines the rate of change.

Changes due to enzymic action undoubtedly proceed when the water content of the samples is high, such as is seen, for instance, when sufficient moisture is present to induce germination*, and it would be interesting to observe the minimum amount of moisture that would be necessary for such process. It is quite certain, however, that, in the conditions under which the examined wheats existed, this point was never reached.

The minimum moisture content necessary to maintain life within the seed is another interesting figure to consider, and lies between fifteen per cent. and forty-five per cent. in the case of wheat if the action of bacteria and moulds be prevented.

In order to obtain this limiting figure, and also with a view to furthering the present knowledge of vitality and its duration in seeds, a number of experiments have been undertaken with the hope that the future examination of them may throw some certain light on the conditions that influence the retention of life within the seed. A full description of these experiments and the objects for which they have been undertaken have been reserved for a later paper, when a complete discussion on their import can be made.

SUMMARY.

The influence of age on wheat grains is not very pronounced when measured by chemical analysis, the principal change which occurs being a marked decrease in the ash content.

This fact, which has been noticed previously by other experimenters, is mainly brought about by the absorption and expulsion of moisture under changing conditions of the atmosphere, whereby the soluble mineral matter is brought to the surface of the grains and, sooner or later, rubbed off.

* Whymper (*Internat. Cong. App. Chem.* 1909).

Increase of acidity with age is another change of importance, and it has been shown that the combination of the loss of mineral matter with an increase in acidity is largely responsible for the degradation of the gluten, which shows itself when the "strength" of the gluten is tested physically. There is no pronounced decrease in nitrogen content attending this physical change.

The chemical analysis of a wheat about three thousand years old does not show any pronounced variation from that of a new wheat except in these two items.

Nor is this of great importance when vitality is to be considered, for the bulk of the grain, the endosperm, is without life, and is only called upon to support life when germination has commenced. On the other hand, it must not be forgotten that the close proximity of the endosperm to the life-containing embryo must result in changes such as loss of moisture, being mutually felt.

When the wheat grains are examined microscopically it is apparent that those of greatest antiquity have suffered considerably at the hands of time, and that the cementing material which binds the bundles of starch together within the endosperm has decomposed, with the result that when such grains are crushed they break up into minute, sharp-pointed fragments, entirely different in appearance to those from newer wheat.

When wetted the dough produced from the flour of the oldest wheat is entirely without "strength," a fact which has been shown to result from a combination of changes, chemical and bacteriological, taking place within the berry.

It is striking that such a degradation of gluten is not noticed also in wheats of fifty years of age, but it is probable that no complete action can take place within the grain until the tough integument has been oxidised or otherwise rendered permeable to air and bacteria.

The suggestion that the vitality of wheat or of any seeds, depends upon the degree and rapidity of desiccation and the thickness of the integument is strongly confirmed; and the loss of moisture, either if too rapid or extended over too great a period of time, would tend to render the protective coating of the seed pervious at a rate more or less rapid according to the efficiency of the integument. On the other hand, the cause of the loss of vitality of wheat in ten years, which is the period recently given by Carruthers and previously by others, must be examined more closely, for neither chemical nor microscopical examination shows that there is sufficient reason for the loss of vitality on these grounds alone in so short a time.

For this reason a number of experiments covering a wide range of environmental conditions has been undertaken.

The experimental tubes, which have been prepared in triplicate, will be examined in ten years' time, and later at periods of ten years' interval if the first results should justify such a procedure.

A description of these experiments has been reserved for a later occasion.

In conclusion, I should be glad to express my thanks to Mr. Paddison who has so admirably prepared the photomicrographs for this research, to Mr. W. A. Davis for supplying me with the wheats of the years 1852 to 1854, and to my uncle, Mr. Charles Whymper, for the specimen of Mummy Wheat, the genuineness of which he has proved both to his and my own satisfaction.

Mr. A. Bradley has assisted me not a little in the practical side of this research, and especially in preparing the tubes and samples for future examination.

A HORSE AND COW IN HARNESS TOGETHER.

Oxen are still well known in most countries as beasts of burden, and horses, in spite of motor cars, may yet remain a little longer with us; but here we have in double harness not an ox, which would be strange enough, but a milch cow yoked with a horse in the hay field.

The photograph, from which Figure 138 has been made, was taken in the summer of 1909 on the golf links at Carlsbad, and the cow as every-day partner in the team did not appear to receive anything but the kindest treatment. A great deal of the work of picking up the haycocks was done by the women with the baskets, one of whom appears in the illustration.

Thus the women, and not the team, did most of the work on the links by bringing their loads on their backs from various parts of the links to the cart.

From a photograph by *L. J. Winter-Joyner.*

Figure 138.

A Horse and Cow in double harness.

THE FACE OF THE SKY FOR MAY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

TABLE 25.

Date.	Sun. R.A.	Sun. Dec.	Moon. R.A.	Moon. Dec.	Mercury. R.A.	Mercury. Dec.	Venus. R.A.	Venus. Dec.	Jupiter. R.A.	Jupiter. Dec.	Uranus. R.A.	Uranus. Dec.	Neptune. R.A.	Neptune. Dec.	Ceres. R.A.	Ceres. Dec.	Pallas. R.A.	Pallas. Dec.
Greenwich Noon.	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°	h. m.	°
May 1	2 32·3	N.15·0	23 10·1	S. 7·0	0 57·5	N 3·0	1 46·7	N.15·7	19 17·2	S.22·2	20 40·3	S.19·0	7 40·7	N.21·0	15 49·9	S.11·7	14 48·0	N23·7
,, 6	2 51·5	16·4	2 54·2	N.20·4	1 22·4	5·6	1 39·4	13·8	19 17·3	22·2	20 40·4	19·0	7 41·1	20·9	15 45·6	11·7	14 43·9	24·4
,, 11	3 10·9	17·8	7 48·2	N.26·0	1 50·6	8·6	1 35·3	12·1	19 17·1	22·2	20 40·5	19·0	7 41·5	20·9	15 41·1	11·7	14 39·9	25·0
,, 16	3 30·6	19·0	12 17·6	S. 2·2	2 22·4	12·0	1 35·4	10·9	19 16·5	22·3	20 40·5	19·0	7 41·9	20·9	15 36·4	11·7	14 36·2	25·3
,, 21	3 50·5	20·1	16 52·2	S. 27·4	2 58·1	15·5	1 38·7	10·2	19 15·7	22·3	20 40·4	19·0	7 42·4	20·9	15 31·7	11·7	14 32·3	25·6
,, 26	4 10·6	21·1	21 27·0	S. 18·7	3 38·4	19·0	1 45·0	9·9	19 14·5	22·4	20 40·2	19·0	7 43·0	20·9	15 27·2	11·8	14 29·8	25·6
,, 31	4 30·9	N.21·9	1 3·3	N. 8·4	4 22·7	N. 22·0	1 54·0	N.10·0	19 13·0	S.22·4	20 39·9	S.19·0	7 43·5	N.20·9	15 22·9	S.11·9	14 27·2	N25·6

TABLE 26.

Date.	Sun. P	Sun. B	Sun. L	Moon. P	Jupiter. P	Jupiter. B	Jupiter. L_1	Jupiter. L_2	Jupiter. T_1	Jupiter. T_2
Greenwich Noon.	°	°	°	°	°	°	°	°	h. m.	h. m.
May 1	−24·3	−4·0	224·4	−21·4	−9·0	−1·7	50·0	1·4	0 47 *m*	9 51 *e*
,, 6	23·3	3·5	158·4	−11·8	9·0	1·7	119·8	33·1	6 33 *e*	1 9 *m*
,, 11	22·1	3·0	92·3	+ 0·8	9·0	1·6	189·7	64·8	6 48 *m*	8 7 *e*
,, 16	20·8	2·4	26·1	+21·8	8·9	1·6	259·7	96·6	2 44 *e*	9 19 *m*
,, 21	19·3	1·8	320·0	+ 6·3	8·8	1·6	329·7	128·5	0 49 *e*	8 26 *m*
,, 26	17·7	1·2	253·8	−17·1	8·7	1·6	39·8	160·4	1 4 *m*	5 29 *e*
,, 31	−15·9	−0·6	187·7	−21·1	−8·5	−1·6	109·9	192·4	6 50 *e*	6 41 *m*

P is the position angle of the North end of the body's axis measured eastward from the North Point of the disc. B, L are the helio-(planeto-)graphical latitude and longitude of the centre of the disc. In the case of Jupiter L_1 refers to the equatorial zone, L_2 to the temperate zone, T_1, T_2 are the times of passage of the two zero meridians across the centre of the disc; to find intermediate passages apply multiples of $9^h\ 50\frac{1}{2}^m$, $9^h\ 55\frac{1}{2}^m$ respectively.

The letters *m*, *e*, stand for morning, evening. The day is taken as beginning at midnight.

THE SUN continues his Northward march. Sunrise during May changes from 4–34 to 3–51; sunset from 7–20 to 8–3. Its semi-diameter diminishes from 15′ 54″ to 15′ 48″. Outbreaks of spots in high latitudes should be watched for.

MERCURY is a morning star till end of month, well-placed for Southern observers. Illumination one-half on 1st, full on 31st. Semi-diameter diminishes from $3\frac{1}{2}''$ to $2\frac{1}{2}''$.

VENUS is a morning star, at greatest brilliancy on 31st, $1\frac{1}{2}°$ North of Moon on 4th. Semi-diameter diminishes from 29″ to 19″. At end of month 0·3 of disc is illuminated.

TABLE 27. Occultations of stars by the Moon visible at Greenwich.

Date.	Star's Name.	Magnitude.	Disappearance. Mean Time.	Disappearance. Angle from N. to E.	Reappearance. Mean Time.	Reappearance. Angle from N. to E.
1913.			h. m.		h. m.	
May 2 ...	Mars	—	7 19 *m*	46°	8 45 *m*	233°
,, 10 ..	47 Geminorum...	5·6	7 50 *e*	103	8 49 *e*	289
,, 10 ...	BAC 2383	6·5	10 16 *e*	55	10 49 *e*	334
,, 13 ...	34 Leonis	6·4	11 22 *e*	89	0 9* *m*	330
,, 16 ...	BAC 4261	6·9	8 15 *e*	203	—	—
,, 17 ...	BAC 4306	6·9	2 3 *m*	137	—	—
,, 17 ...	Spica	1·2	—	—	4 39 *e*	345
,, 17 ...	BAC 4531	6·0	10 2 *e*	176	10 46 *e*	253
,, 20 ...	BAC 5111	6·3	1 55 *m*	123	3 2 *m*	268
,, 23 ...	Lacaille 7730	7·0	-	—	0 57 *m*	269
,, 23 ...	Lacaille 7759	7·0	—	—	2 39 *m*	276
,, 26 ...	ϕ Capricorni	5·3	2 41 *m*	44	3 57 *m*	265

The asterisk indicates the day following that given in the Date column.

From New to Full disappearances take place at the Dark Limb, from Full to New reappearances.

The occultation of Mars takes place in daylight, but from experience of a similar phenomenon I know that its observation will be possible with (say) a six-inch telescope if the weather is good. The occultation of Spica is also in daylight and as the Moon will have just risen it will be difficult to observe.

XUM

Being south of Sun, it is less well placed for Northern observers than it was as an evening star.

THE MOON.—New $6^d\ 8^h\ 24^m\ m$; First Quarter $13^d\ 11^h\ 45^m\ m$; Full $20^d\ 7^h\ 18^m\ m$; Last Quarter $28^d\ 0^h\ 4^m\ m$. Perigee $16^d\ 2^h\ m$, semi-diameter 16′ 15″. Apogee $28^d\ 8^h\ m$, semi-diameter 14′ 49″. Maximum Librations, 7^d 5° E, 9^d 7° S., 22^d 5° W., 22^d 7° N. The letters indicate the region of the Moon's limb brought into view by libration. E. W. are with reference to our sky, not as they would appear to an observer on the Moon.

MARS is a morning Star, but not yet well placed for observation.

CERES and PALLAS are well placed for observation. They are of magnitude 7 and 8 respectively.

JUPITER is a morning star. Polar semi-diameter, 20″.

TABLE 28.

Day.	West.	East.	Day.	West.	East.
May. 1	41 ○ 23		May. 17	412 ○ 3	
,, 2	42 ○ 13		,, 18	43 ○ 12	
,, 3	41 ○ 3	2●	,, 19	431 ⊙	
,, 4	43 ○ 12		,, 20	432 ○ 1	
,, 5	4312 ○		,, 21	41 ○ 2	
,, 6	432 ○ 1		,, 22	4 ○ 123	
,, 7	413 ○ 2		,, 23	42 ○ 3	1●
,, 8	4 ⊙ 23		,, 24	421 ○ 3	
,, 9	2 ○ 143		,, 25	3 ○ 412	
,, 10	1 ○ 34	2●	,, 26	31 ⊙ 4	
,, 11	3 ○ 124		,, 27	32 ○ 14	
,, 12	312 ○ 4		,, 28	31 ○ 24	
,, 13	32 ○ 14		,, 29	○ 1324	
,, 14	1 ○ 24	3●	,, 30	21 ○ 34	
,, 15	○ 1234		,, 31	2 ⊙ 34	
,, 16	2 ○ 43	1●			

Configurations of Jupiter's satellites at $2^h\ m$ for an inverting telescope.

Satellite phenomena visible at Greenwich, $1^d\ 1^h\ 39^m$ I. Tr. E., $2^h\ 58^m$ II. Sh. I.; $3^d\ 2^h\ 29^m$ II. Oc. R.; $7^d\ 0^h\ 36^m\ 43^s$ III. Ec. R., $2^h\ 11^m$ III. Oc. D.; $2^h\ 54^m\ 46^s$ I. Ec. D.; $8^d\ 1^h\ 11^m$ I. Tr. I., $2^h\ 19^m$ I. Sh. E., $3^h\ 20^m$ IV. Oc. D., $3^h\ 29^m$ I. Tr. E.; $9^d\ 0^h\ 47^m$ I. Oc. R.; $14^d\ 1^h\ 37^m\ 25^s$ III. Ec. D.; $15^d\ 1^h\ 56^m$ I. Sh. I., $2^h\ 59^m$ I. Tr. I.; $16^d\ 1^h\ 24^m$ IV. Sh. I., $2^h\ 36^m$ I. Oc. R., $3^h\ 31^m$ IV. Sh. E.; $16^d\ 11^h\ 44^m e$ I. Tr. E.; $17^d\ 2^h\ 27^m\ 58^s$ II. Ec. D.; $19^d\ 0^h\ 16^m$ II. Sh. E., $2^h\ 19^m$ II. Tr. E.; $22^d\ 3^h\ 49^m$ I. Sh. I.; $23^d\ 1^h\ 10^m\ 52^s$ I. Ec. D.; $23^d\ 11^h\ 13^m e$ I. Tr. I.; $24^d\ 0^h\ 35^m$ I. Sh. E. $1^h\ 31^m$ I. Tr. E.; $25^d\ 2^h\ 14^m$ III. Tr. E.; $26^d\ 0^h\ 3^m$ II. Sh. I., $1^h\ 52^m$ II. Tr. I., $2^h\ 52^m$ II. Sh. E.; $30^m\ 3^h\ 4^m\ 46^s$ I. Ec. D.; $31^d\ 0^h\ 11^m$ I. Sh. I., $0^h\ 59^m$ I. Tr. I., $2^h\ 28^m$ I. Sh. E., $3^h\ 17^m$ I. Tr. E.; $31^d\ 11^h\ 16^m e$ III. Sh. I.

All the above, except the three marked *e*, are in the morning hours.

SATURN is invisible, being in conjunction with the Sun on the 29th.

URANUS is a morning star, coming into a better position for observation.

NEPTUNE is an evening star and was stationary on April 4th. Its motion may be traced on the map of small stars which was given in "KNOWLEDGE" for December, 1911, page 476.

METEOR SHOWERS (from Mr. Denning's List):—

Date.	Radiant. R.A.	Radiant. Dec.	Remarks.
Mar. to May	263°	+ 62°	Rather swift.
April to May	193	+ 58	Slow, yellow.
April to May	296	+ 0	Swift, streaks.
May 1 to 6	338	− 2	Aquarids, swift, streaks.
,, 7	246	+ 3	Slow, bright
,, 11 to 18	231	+ 27	Slow, small.
,, 30 to Aug.	333	+ 28	Swift, streaks.
,, June	280	+ 32	Swift.
,, to July	252	− 21	Slow, trains.
,, 18 to 31	245	+ 29	Swift, white.

DOUBLE STARS AND CLUSTERS.—The tables of these given last year are again available, and readers are referred to the corresponding month of last year.

VARIABLE STARS.—Tables of these will be given each month; the range of R.A. will be made four hours, of which two hours will overlap with the following one. Thus the present list includes R.A. 12^h to 16^h, next month 14^h to 18^h, and so on.

TABLE 29. NON-ALGOL STARS.

Star.	Right Ascension. h. m.	Declination.	Magnitudes.	Period. d.	Date of Maximum.
R Comae	12 0	+19 ·3	7·3 to 14	$361\frac{1}{5}$	June 8.
SU Virginis	12 1	+12 ·9	8·8 to 13	205	May 10.
T Virginis	12 10	− 5 ·5	8·2 to 13	$339\frac{1}{2}$	May 15.
T Can. Ven.	12 26	+32 ·0	8·6 to 11·8	$290\frac{1}{2}$	Mar. 26.
R Virginis	12 34	+ 7 ·5	6·2 to 11·1	$145\frac{1}{2}$	May 4.
RU Virginis	12 43	+ 4 ·7	7·6 to 11·8	440	May 26.
U Virginis	12 47	+ 6 ·0	7·7 to 13	206·9	May 29.
RR Urs. Maj.	13 23	+62 ·8	8·6 to 13	$229\frac{1}{2}$	Apr. 3.
R Hydrae	13 25	−22 ·8	3·5 to 10·1	425	Apr. 17.
T Urs. Min.	13 33	+73 ·9	8·8 to 13	321	Mar. 26.
V Urs. Min.	13 37	+74 .8	7·5 to 8·7	71	Mar. 28.
U Urs. Min.	14 16	+67 ·1	7.6 to 12	327	May 29.
S Bootis	14 18	+54 ·3	7·7 to 13	273	July 9.
R Camelop	14 24	+84 ·2	7.2 to 13	269·5	June 3.
R Bootis	14 33	+27 ·1	5.9 to 12	223·3	June 19.
RR Bootis	14 44	+39 ·7	8·0 to 13	196·5	May 18.
Y Librae	15 7	− 5 ·7	8·0 to 11·3	365	June 12.
RS Librae	15 19	−22 ·6	6.6 to 12	217	May 20.
RU Librae	15 28	−15 ·0	8·4 to 11	314	June 24.
X Coronae	15 46	+36 ·5	8·4 to 13	246	May 13.
R Serpentis	15 47	+15 ·4	5·6 to 13	357	May 16.
RR Librae	15 51	−18 ·0	8.2 to 12·6	276.7	June 22.
Z Coronae	15 53	+29 ·5	8·9 to 14	245	May 20.
T Coronae	15 56	+26 ·2	Now 9·5		Nova Coronae.

JOHN GRAY, B.Sc.

By G. UDNY YULE.

READERS of "KNOWLEDGE" will have heard with regret that Mr. John Gray, the inventor of the curious and interesting machine for estimating mental characteristics, described in "KNOWLEDGE" of December, 1910, passed away at the end of April, 1912, as the result of an attack of pneumonia, and a a few details with regard to his career will prove acceptable.

Gray was born in 1854, at Strichen, Aberdeenshire, and was educated as an engineer at the University of Edinburgh and the Royal School of Mines, London; he obtained the Associateship of the School in Metallurgy in 1878, and the degree of B.Sc. (Engineering) at Edinburgh in the following year. In 1878 he entered the Patent Office, and at the time of his death held the position of Examiner, specialising largely in patents relating to electrical inventions. During the earlier part of his life, Gray's interests lay almost wholly in matters relating to physics and electrical engineering. He was a fellow of the Physical Society from 1879 to 1905, and an Associate of the Institution of Electrical Engineers from 1887 to 1902. For some twenty years, even to the year before his death, he was a regular and valued contributor to *The Electrical Review*. To many students of physics his book on electrical influence machines, which was published in 1890, and reached a second edition in 1903, will be well known.

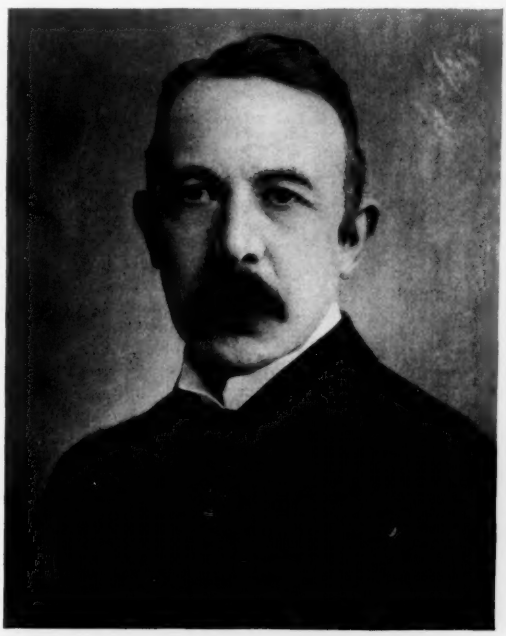

FIGURE 139. The late John Gray, B.Sc.

His first contribution to anthropology was a paper on the history of the place of his birth, published in *The Transactions of the Buchan Field Club* for 1893. This was followed by several other contributions to the Transactions of the Club, and, with the co-operation of members of the Club, an anthropometric survey of some fourteen thousand school children was carried out on a scheme devised by Gray, the results of which were published in its Transactions in a joint review by Gray and Tocher in *The Journal of the Anthropological Institute* (1900). These Aberdeenshire surveys paved the way for the survey of the whole of the school children of Scotland. A committee was formed consisting of Sir Wm. Turner, Professor Reid, Mr. Gray and Mr. Tocher, financial assistance obtained from the Royal Society Government Grant Committee, and the survey organised and very successfully carried out by Mr. Gray and Mr. Tocher. Gray's memoir on the results was published in *The Journal of the Anthropological Institute* for 1907. Mr. Gray acted as Secretary of the Anthropometric Committee of the British Association (1902–8), and in 1903, in conjunction with Professor D. J. Cunningham, he submitted to the Interdepartmental Committee on Physical Deterioration a scheme for an anthropometric committee of the British Isles.

Gray possessed very marked mechanical abilities, and devised a number of new instruments or new forms of instrument for anthropometric work, *e.g.*, a portable stature meter, callipers, a radiometer, a perigraph or instrument for drawing contours of skulls or bones, and an adaptation of Lovibond's tintometer for analysing the colour of hair, skin or eyes. During the last few years he had been specially interested in the machine referred to at the commencement of this notice. In its first form this instrument measured the speed at which the observer ceased to see flicker in a revolving disc coloured in black and white segments, the disc being replaced in the later and improved form ("KNOWLEDGE" *loc. cit.*) by a revolving mirror reflecting alternately white and coloured light. The actual speed was very nearly constant for the same observer, but varied greatly for different persons, and seemed to exhibit remarkable relations to the mental characteristics. He was still at work on this machine at the time of his death.

That Gray possessed not only scientific abilities and skill in mechanical invention, but also great capacity for organisation, will have been evident from his work on the anthropometric surveys. This capacity he placed at the service of the Anthropo-

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logical Institute, when, in 1904, he accepted the Treasurership and by untiring effort succeeded in placing the finances on a sound basis. He also acted as Treasurer of the Universal Races Congress of 1911, and at the time of his death was serving as Assistant Treasurer of the Congress of Americanists. In 1909 he was elected a foreign associate of the Anthropological Society of Paris.

A NEW GRATING SPECTROGRAPH.

By A. H. STUART, B.Sc., F.R.A.S.

THOSE of us who have read how Fraunhofer made diffraction gratings by winding silver wire of diameter ·04mm. on brass frames and then, with them, measured the wave lengths of lines in the solar spectrum with a surprising degree of accuracy, have envied little except his *patience*. We have only envied others their *apparatus* when we have read of the wonderful reflection gratings made by Rowland, and the huge map of the sun's spectrum which he obtained by their aid. This map set the pace, so to speak, in this class of work, and is still of considerable value as a standard, in spite of the classical work which Michelson has done with his interferometer. It is the dealers' catalogues that are responsible for stifling our enthusiasm for work with reflection gratings, for even a small instrument of this type costs from £10 to £20. By the judicious expenditure of £1, however, I have been able to construct a spectrograph on this principle.

Figure 140 shews this instrument in diagram. S is the slit of the instrument, L is an achromatic lens (2-ins. diameter and 30-in. focal length, value 3s. 6d). Immediately behind L is placed a transmission grating (a moulded replica on glass, value 10s. 6d., gives good results), with the prepared surface as close to the lens as possible. Behind this again, is placed a plane mirror M. C is a camera-back upon which the spectrum produced is focused. The distance from L to S and L to C should be equal to the focal length of the lens L. The whole is contained in a light-tight wooden box, PQRS in figure.

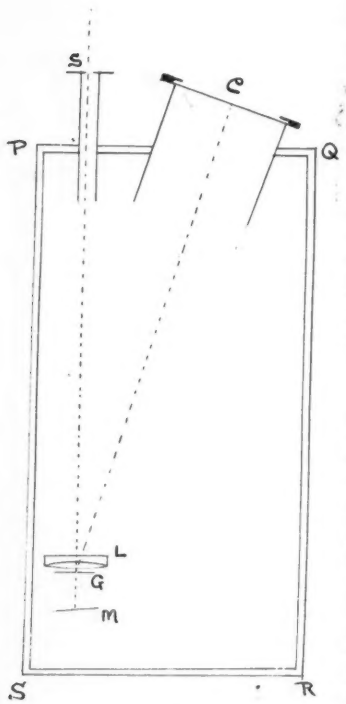


FIGURE 140.

Now in order to get the various parts of the instrument correctly fixed, it is necessary to consider in detail what happens to a pencil of light when it falls on to the grating. For our purpose we may neglect all except the spectra of the first order, and it will be convenient to consider the rays which have suffered the least deviation (with a grating the violet end of the spectrum is deviated the least). If we use a glass lens all rays in the ultra-violet beyond $\lambda = 3600$ will be absorbed. Now in Figure 141 the light travels down from S and falls on the grating G normally. A large portion of this light passes through the grating unchanged, and falls on the mirror M at A. If it meet the mirror normally it will be reflected back to the grating and a spectrum will pass out towards C. This is the spectrum which is to reach the camera. Other spectra are, however, formed, and these must be avoided. Those which are deviated to the right may be neglected, since they are absorbed by the side of the containing box (which should be blackened). When the light first falls on the grating a spectrum will be deviated to the left and will be reflected by the mirror towards B. The mirror must be so placed that this spectrum does not fall on the lens. Using a grating having 14,438 lines to the inch, the angle θ for $\lambda = 3600$ is about 14° 39′, and in order that the ray B may just miss a lens 2 inches in diameter, the mirror must be placed 3·9 inches behind the lens. There is yet another spectrum to be considered. The light falling on the grating in the first case will form a faint reflection spectrum which will, under the present conditions, be more or less superimposed on the spectrum we want to photograph. To avoid this I have found it convenient to retain the grating at right angles to the incident light, but to have the mirror slightly twisted, as shewn in Figure 140. This will separate the spectrum we want from the faint one caused by reflection from the grating surface.

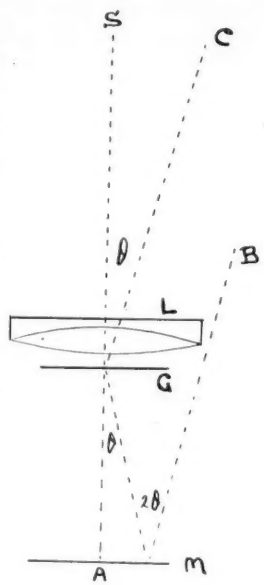


FIGURE 141.

We thus have in the camera a pure spectrum of considerable dispersion at a very trifling instrumental cost and the sacrifice of a little light.

It is wise to hang a black screen across the box, so that the lens just protrudes; this will absorb any stray reflections from the mirror.

By having a piece of wood just large enough to fit into the rebates of the camera back, and mounting in the middle of it an ordinary telescope eyepiece, the instrument may be used as a spectroscope. I have found it convenient to mount the mirror (M in Figure 140) on a turntable, and to have a long lever attachment (very much geared down) regulated from near the eyepiece. By this means a steady movement of the mirror will cause the whole of the visible spectrum to move slowly across the field of view.

SOLAR DISTURBANCES DURING FEBRUARY, 1913.

BY FRANK C. DENNETT.

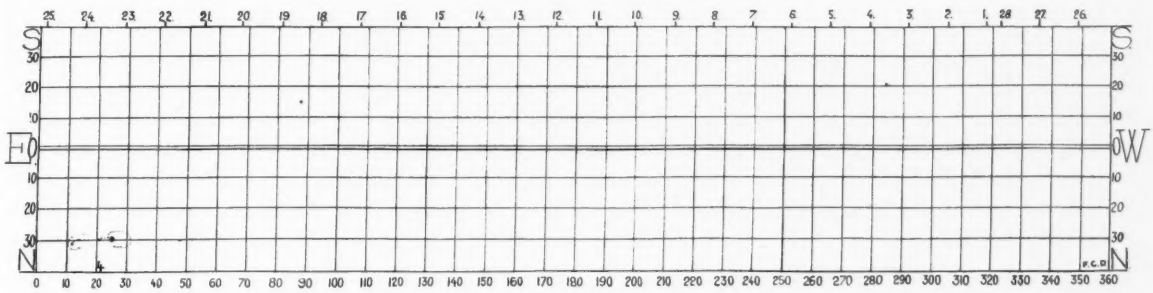
FEBRUARY has yielded a much better proportion of observing days than did the previous month. On only two—3rd and 12th—was the sun quite missed, but of the remaining days the disc appeared quite free from disturbance on no less than fifteen, as none was seen until the 18th. The central meridan at noon on February 1st, was 318° 0′.

No. 4.—On the 18th a bright faculic cloud was noted round the north-eastern limb, which on the evening of the 19th was found to contain pores. On the 20th there were three spotlets and some minute pores, but next day the leader was some 9,000 miles in diameter, and the group about 45,000 miles in length. On the 22nd and 23rd a trail of three or four pores stretched back from the southern side of the leader, and a somewhat lesser trail reached forward from the back spotlet, the group now extending over 82,000 miles. From the 24th to the 26th, only the leader was visible with a small pore closely south-east, the latter being gone on the 27th. On the 28th only the faculae remained visible in place of the group. The high northern latitude of this disturbance quite marks it as belonging to the new cycle.

Although only one disturbance has been recorded during the month, and that showing but little activity from a spectroscopic point of view, except upon the 21st and 22nd, when the C. line showed much deflection, and at one time an eruptive flocculus, it is probable that during the present year there will be a gradual but marked increase of disturbance.

The observers have been Messrs. John McHarg, C. J. Simpson, D. Booth, W. H. Izzard, C. Frooms, E. E. Peacock, and the writer.

DAY OF FEBRUARY.



NOTES.

ASTRONOMY.

By A. C. D. CROMMELIN, B.A., D.Sc., F.R.A.S.

STELLAR PARALLAX.—An important programme in this field has been carried out at the Observatory of Yale University by Messrs. F. L. Chase and M. F. Smith. An interesting summary of the results is given in *Popular Astronomy* for February, which we reproduce below in Table 30:—

TABLE 30.

Proper Motion.	″·00 to ″·34.		″·41 to ″·54.		″·55 to ″·65.		″·66 to ″·96.		″·97 to 7″·04.		Mean.	
Magnitude.	Mean Par.	No.	Mean Par.	No.	Mean Par.	No.	Mean Par.	No.	Mean Par.	No.	Mean Par.	No.
0 to 3	″·02	18	″·10	2	″·11	3	″ —		″·20	2	″·06	25
3 „ 5	·03	9	·02	7	·11	5	·10	10	·18	7	·08	38
5 „ 7	—·01	7	·04	17	·06	19	·04	18	·09	15	·05	76
7 „ 9	—		·04	31	·03	26	·02	27	·12	15	·04	99
Means	·01	34	·04	57	·05	53	·04	55	·12	39	—	

As might be expected, the parallax increases with the proper motion. The dependence on brightness is less marked, but it is to be remembered that while the list is fairly exhaustive for the brighter stars, it only contains selected faint ones, chosen on account of sensible proper motion. The following large parallaxes were found:—

	Par.
ϵ Eridani	″·31
δ Eridani	·18
W.B. XVI 906	·21

The last is a faint star of magnitude 8·8, the proper motion being 1″·29. ϵ Eridani appears to be one of the Sun's twelve nearest neighbours.

SUNSPOTS.—Mr. Maunder contributes an interesting article on Sunspots to the January number of *Scientia*. He first points out the abruptness of the transition from spot-activity to quiescence, which is frequently accomplished in a

single year. He then passes to consider Spoerer's law of fluctuation of spot zones. At the beginning of a cycle, spots break out in high north and south latitudes, and as the cycle progresses they gradually close in on the equator. There is an overlap of a year or two between one cycle and the next, equatorial spots belonging to the expiring cycle appearing concurrently with the high-latitude spots of the new one. We are now in this period of overlap, spots of the new cycle having begun to appear in December, and one in latitude 37° North having crossed the central meridian on February 23rd. Mr. Maunder considers that this fluctuation in latitude indicates that the spot-cycle is not due to external bodies such as planets, comets, or meteor swarms, but is due to some change within the Sun itself.

He further holds that since the variation in latitude synchronises with the eleven year cycle of activity, and with no other cycle, this is the only genuine cycle of sunspot change. Professor Schuster announced cycles of 4·79 years and 8·36 years from his "Periodogram" treatment of the numbers expressing the daily spotted area. But these periods do not fit in with the latitude shift of the spots, and Mr. Maunder denies their reality as genuine solar cycles. He suggests that the periodogram has indicated them since they may be times "in which the average life of a normal group of spots becomes commensurate with half the synodic rotation period of the Sun."

POSSIBLE SHORT PERIOD VARIATIONS IN THE SOLAR RADIATION.—The Mount Wilson observations having suggested that there were real variations in the Sun's radiation, it was decided that Messrs. Abbot and Angström should make observations in Algeria, while Mr. Aldrich observed on Mount Wilson. It was very improbable that any influence that was merely terrestrial would simultaneously affect these distant stations in the same manner. The results of 1911 are considered to make the variation of the Sun to an extent of ten per cent. in a period of a few days highly probable.

The weather conditions in 1912 were more favourable, and it is hoped that the observations made then will suffice to settle the question.

The *a priori* probabilities are considerably against so large a variation in so short a period. But it must be admitted that if the observations in Africa and California systematically agree, they would go far to establish its reality.

MEASURES OF THE PLANETS.—The fourth volume of *The Annals of Strassburg Observatory* contains a series of measures of the dimensions of the planets.—

	In angle at distance unity.	In miles.
Mercury	6″·431	2,893
Venus	16 ·782	7,552
Mars	9 ·674	4,352
Jupiter, Equat. ...	199 ·04	89,553
Polar ...	187 ·23	84,242
Saturn, Equat. ...	171 ·65	77,232
Polar ...	153 ·44	69,038
Diam. of Ring	382 ·70	172,191
Uranus	67 ·90	30,550
Neptune	69 ·30	31,180

H. Samter has deduced the mass of Titan from its perturbing effect on Hyperion. Two different methods gave 1/4125 and 1/3910, Saturn being taken as unity. The accordance is good. In giving diameters in miles, Hinks' value of the Sun's Parallax, 8″·807, has been used.

The compression of Jupiter is given as $\frac{1}{16\cdot87}$

" " " Saturn " " " $\frac{1}{9\cdot426}$

It is curious how difficult it is to decide which of the two outermost planets is the larger. The earlier measures gave Neptune, most recent ones give Uranus, while the present series is again in favour of Neptune. The diameter of Mars is almost exactly twice that of the Moon.

BOTANY.

By PROFESSOR F. CAVERS, D.Sc., F.L.S.

WEEDS OF ARABLE LAND.—Miss Winifred Brenchley (*Annals of Botany*, 1911, 1912, 1913) has published three papers dealing respectively with investigations carried out in (1) Bedfordshire on soils derived from the Chalk, Gault, Lower Greensand, and Oxford Clay; (2) parts of Somerset and Wiltshire, the Upper Greensand, Chalk, and Clay (Fuller's Earth) coming under consideration; and (3) Norfolk, on a variety of soils, including gravel, sand, loam, and clay, forming the drift deposits known as North Sea Drift and Boulder Clay, in addition to the outcrops in West Norfolk of the Chalk, Gault and Lower Greensand. The author's object was to determine the relations existing between the weeds, soils, and crops of arable land. The more important weeds are classified with their habits and relative dominance, and details are given as to the weeds of clay, chalk, sandy, and other soils. In the second paper, special mention is made of the "calcifuge" species.

It is shown that in each district investigated a definite relation exists between the weeds of arable land and the soils on which they grow. This relation may be *local*, when a weed is symptomatic of a certain soil in one district but is not so exclusively associated with it in another; or *general*, when a certain species is symptomatic or characteristic of the same type of soil in different districts. The determining factor of the association is the actual texture of the soil, and not so much the geological formation from which it is derived, except with soils overlying chalk. The crop has very little influence on the weeds occurring except in the case of seed crops, which probably smother out species which would normally occur. The weeds found in seed crops seem to be constant, and certain other plants show the same association with particular types of crop in various districts. The relative prevalence of the weeds varies somewhat in the different districts, certain species which are more or less common in one place being practically absent in another, on similar soils.

Naturally, the general relations will need more exhaustive proof than the local relations, and a true estimate will only be obtained as the field of investigation is enlarged, since each fresh observation ratifies or discounts the previous deductions. In the first two papers, dealing with Bedfordshire, Somersetshire and Wiltshire, special care was taken to select districts without drift deposits, so that the soils might be regarded in the main as derived from the geological formations immediately underlying them, *e.g.*, Greensand, Chalk, Gault. The conclusion that the geological derivation has little to do with determining the weed flora, and that the texture of the soil is a far more important factor, was fully verified by the results of the investigations made in Norfolk on drift soils. In one district a curious mingling of "acid" and "chalk" plants was found, possibly owing to the super-position of a thin layer of non-calcareous sand on a chalk subsoil, the difference in the root-systems of the plants enabling each to tap the particular soil most suited to its needs.

WIND AND TREE-GROWTH.—Even the most casual observer, who has been at the sea-coast or on mountain heights, must have noticed that full exposure to strong winds coming from one direction has a marked influence on the appearance of trees. In such exposed situations the entire tree may lean with the prevailing wind, or the trunk may grow erect while all the branches are on the leeward side, the branches which come out on the windward side being apparently bent round in the opposite direction by the force of the wind, and kept bent in this way so continuously that the growth and hardening of the wood has finally fixed the branch in this position. At any rate, this appears to be the simplest explanation, and a good example of the power of habit—the young branch finds it easier to bend with the wind than to resist it, and when it becomes old this habit is fixed and the bent and gnarled branches could not then straighten even if the wind abated. Hence, it has usually been supposed that the permanent bending of trees and of their branches in the direction of the wind is due to the mechanical action of the

wind, and also to the pruning action of sharp salt or cold winds, which shrivel up the buds on the windward side as soon as they appear on the tree—this would account for the absence of branches on this side of the tree, which is often observed.

However, Jaccard (*Journ. forest. suisse*, 1912) has called this explanation in question, and has put forward a very different one. He takes into account not only the general form of the tree, but also the effect of growth in exposed places upon the thickening of the trunk; emphasizes the fact that there is a close relationship between growth of the leafy crown, the activity of the cambium or growing layer between wood and bark, and the extension of the root system in the soil; and points out that variations in the rate of water transport up the stem play an important part in the progress and localisation of growth in thickness of the wood. He gives the results of extensive comparisons of sections of the wood, showing the anatomical correlation between roots, trunk, and branches, in support of his contention that the modifications in direction of growth, and in the secondary thickening of the woody trunk and twigs, are due to various factors concerned in the nutrition of the plant rather than to the mere mechanical action of the wind, which he does not consider affords a complete explanation of this familiar phenomenon.

Jaccard's observations and interpretations are of great interest, but further work on the subject appears to be required before one can feel convinced that his main conclusion is correct; for it is somewhat difficult to see how the characteristic ⅂-shaped form of trees exposed to strong winds can be fully explained without reference to the mechanical action of the prevailing wind.

THE GRAFT-HYBRID *CYTISUS ADAMI*.—The remarkable experiments of Winkler and Baur on the production of "graft-hybrids" and "chimaeras" were described in these columns some time ago ("KNOWLEDGE," 1911, page 186). At the meeting of the Royal Society on June 20th, 1912, Professor Keeble and Dr. E. F. Armstrong read a paper on "The Oxydases of *Cytisus Adami*." The investigation described in this paper was undertaken with a two-fold object: (1) to test Baur's hypothesis that this graft-hybrid is a periclinal chimaera composed of an epidermis derived from *Cytisus purpureus* and a body derived from *Cytisus Laburnum*, and (2) to ascertain whether migration of oxydases (oxidising ferments) may occur in plants. The results confirmed Baur's conclusions, and indicated that oxydases may pass from one tissue to another. Tests applied to the flowers of the three forms showed that *C. Adami* and *C. purpureus* contain a direct epidermal oxydase and that *C. Laburnum* does not; also that a direct oxydase is contained in the veins of *C. purpureus*, while the veins of *C. Adami* and *C. Laburnum* contain peroxydase and not a direct oxydase. In other words, *C. Adami* is identical with *C. purpureus* with respect to its epidermal oxydase, and with *C. Laburnum* with respect to its bundle (vein) oxydase.

The evidence pointing to oxydase migration is as follows: The buff standards of *C. Adami*, like the yellow standards *C. Laburnum* are marked by lines of chocolate colour, due to anthocyan pigment contained in sub-epidermal cells. Sections across these pigmented areas of *C. Adami* show that they coincide with deeply pigmented epidermal cells. Over the other parts of the standard the pigmentation of the epidermis is faint; over the sub-epidermal pigmented areas it is well-marked. Inasmuch as the fainter pigmentation is due to inhibition of pigment-formation it is concluded that the deeper pigmentation is to be attributed to the passage of oxydase from sub-epidermal pigmented cells to contiguous epidermal cells.

The failure of the buff flowers of *C. Adami* to develop their purple pigment as fully as that pigment is developed in the purple flowers becomes intelligible on the hypothesis of oxydase-migration; for, whereas the purple-flowered branches contain a bundle oxydase which may reinforce that of the epidermis in affecting pigment-formation, the vascular tissues of *C. Adami* contain no direct oxydase and hence cannot aid the epidermal cells in their work of pigment-production.

In connection with this interesting "chimaera," mention may be made of a paper by Janssonius and Moll (*Rec. trav. bot. Néerlandais*, 1911, page 333–368) on the minute structure of the wood of *Cytisus Adami* and its components. These writers find that, as might be expected, the wood of this form closely resembles that of the laburnum and differs from that of *C. purpureus*. The wood of *C. Adami* cannot be said to be on the whole intermediate in structure between that of the two "parents," but shows certain peculiarities which may be due to the influence of *C. purpureus*.

Buder (*Ber. deutsch. bot. Ges.*, Band 28; *Zeit. f. indukt. Abst.-u. Verereb.-Lehre*, Band 5) has made a very thorough study of the minute structure of *Cytisus Adami*, and has added various details to the descriptions of previous writers. He also confirms the view, established by the work of Macfarlane, Baur, and Winkler, that this form is a periclinal chimaera. He finds that the protoplasm of the epidermal cells is joined to that in the cells below by fine threads passing through the cell-walls, just as is the case with the various cells making up the living tissues of plants in general. The nuclei of *C. Laburnum* are smaller than those of *C. purpureus*; those of the epidermis in *C. Adami* are of the *purpureus* size, those of the underlying cells are of the *Laburnum* size. In *C. purpureus* nearly all the cells contain tannin; in *C. Adami* it is present only in the epidermis. In *C. purpureus* the cork-producing cambium arises in the sub-epidermal layer, in *C. Laburnum* in the epidermis itself; in *C. Adami* the cork may be formed from the hypodermis, or from the epidermis or from both layers—all three cases may be seen in the same twig. In such details as effect the epidermal layer of cells (form of hairs, cuticle, stomata, and so on), *C. Adami* agrees exactly with *C. purpureus*. A curious detail is the fact that in *C. Adami* the nucellus of the ovule projects beyond the micropyle; this is easily explained as owing to the rapid growth of the inner (*Laburnum*) tissue of the ovule as compared with the outer (*purpureus*) integument.

CHEMISTRY.

By C. AINSWORTH MITCHELL, B.A. (OXON), F.I.C.

HYDRIDES OF BORON.—Many attempts have been made to prepare definite hydrides of boron, but the instability of these compounds has hitherto prevented their isolation in a pure state. These difficulties have been overcome by Messrs. Stock and Massenez (*Ber. d. deut. Chem. Ges.*, 1912, XLV, 3539), who have succeeded in preparing definite compounds of hydrogen and boron by causing magnesium boride to fall little by little into slightly heated dilute hydrochloric acid. The gases evolved in the reäction were condensed in a series of tubes chilled by means of liquid air, and the condensed portions were then fractionated by replacing the liquid air, first by a mixture of acetone and solid carbon dioxide (−82°C. to −75°C.), then by liquid ammonia (−45°C. to −35°C.), and finally by ice.

By these means two hydrides of boron were isolated, with compositions corresponding to the formulae B_4H_{10} and B_6H_{12}. The first of these melted at about −112°C., and easily decomposed into a series of other boron hydrides. In the gaseous form it ignited spontaneously in the presence of air or oxygen, and produced dangerous explosions in vessels with narrow openings.

The other hydride, B_6H_{12}, was a colourless liquid, which had a repulsive odour, and, like its companion, took fire spontaneously on contact with air. At the ordinary pressure it boiled at about 100°C. It was readily decomposed by water, and, when treated with alkali solutions, yielded hydrogen. A trace of this hydride left in a vessel may give rise to a dangerous explosion on admission of air, and it is recommended as a precaution that the flasks should be rinsed with a solution of sodium hydroxide before allowing any air to enter.

THE BIRTH OF AN ATOM.—Two papers were recently read before the Chemical Society, the importance of which to physics and chemistry it is hardly possible to over-estimate. At the time of writing, the official account has not been published, but an excellent outline, taken from a report to *The*

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Morning Post, will be found in *The Chemical News*, 1913, CVII, 78.

As has happened on several previous occasions in science, the same discovery has been independently made by more than one worker, approaching the subject from different points of view.

The first of these papers, "On the Presence of Helium in the Gases from the Interior of X-ray Tubes," was read by Sir William Ramsay, and was the outcome of his attempts to obtain evidence of chemical transformations effected through the agency of the β-rays given off in the decomposition of radium emanation. With this idea several old X-ray tubes were examined, and in each case helium, neon and argon were found in the gases within them. Possibly this helium was produced by the impact of the rays upon the glass walls of the tubes. As to the neon, its origin was suggested by the fact that on decomposing water by means of radium emanation, neon is produced in proportions indicated by the equation:—

Helium	+	Oxygen	=	Neon.
4		16		20

These experiments of Sir William Ramsay were supplemented by the second paper on "The Presence of Neon in Hydrogen after passage of an Electric Discharge through Hydrogen at Low Pressures," which embodied results independently obtained by Professor Collie and Mr. H. Patterson.

In this paper it was shown that when an electric discharge was passed through a vacuum tube containing hydrogen, helium and neon (which could be identified by their spectra), were invariably produced.

All precautions were taken to exclude the possibility of the introduction of any helium during the experiments, so that the conclusion was justified that there were only two explanations of the phenomenon:—(1) That the hydrogen or elements in the glass or electrodes had been transmuted into helium and neon; or (2) That the energy of the discharge had created helium and neon from the immaterial ether.

Mr. Patterson suggested that a possible hypothesis from the purely physical standpoint was that by doubling the electric charge upon the atom of hydrogen it might conceivably be converted into α-particles and so into helium.

When the experiments were repeated, with the tube containing hydrogen surrounded by an outer vacuum tube, helium was found in the latter, apparently owing to its diffusion through the glass of the inner tube. On then introducing pure oxygen into the outer tube, neon was obtained, the equation suggesting the same proportions as observed by Sir William Ramsay:—

Helium	+	Oxygen	=	Neon.
4		16		20

Hence the conclusion was drawn that if the helium produced in the inner tube had sufficient velocity to diffuse into the outer tube, it was quite possible for a new element, neon, to be formed.

It is now accepted as a proved fact that the element radium decomposes with the formation of other elements, the simplest of which is apparently helium, and the experiments of Sir William Ramsay have indicated that the energy liberated by radium can effect the transmutation of other elements into one another; but in such cases man can only watch the changes that go on, and cannot control or vary them. But in the building-up process that has apparently now been discovered, the energy for the change is artificially supplied and controlled, and the changes are thus of a different order from the radioactive decompositions of a decaying element.

To quote the words of Professor Collie—"We are possibly dealing with the primordial form of matter, the primordial atom, which when produced had all the energy necessary for forming the world. By combination of these 'atoms' the atoms of elements could be formed. Possibly the electric current directed the flow of these atoms with the full force of its energy, and with the phenomena of heat and light the elements came into existence."

GEOLOGY.

By G. W. TYRRELL, A.R.C.Sc., F.G.S.

RECENT AMERICAN MEMOIRS.—Geologists in the United States are fortunate in having a large number of periodicals and transactions in which to publish their work; and, judging from the elaborate and expensively-illustrated memoirs which are constantly being turned out, these societies must have plenty of money to spend. The United States Geological Survey also publishes on a lavish scale. Some recently-issued memoirs are noticed below.

A "Bibliography of the Geology and Mineralogy of Tin," by F. L. Hess and Eva Hess (Smithsonian Miscellaneous Collections, Vol. LVIII, No. 2) is a very elaborate and exhaustive work, containing one thousand seven hundred and one entries. These are principally listed under countries, but subordinate headings are General Bibliography, Mining and Milling, History, Metallurgy, Chemistry, Mineralogy and Statistics. Of the more important papers useful digests have been prepared. An index covering one hundred and sixty-nine pages completes the usefulness of this work.

"The Early Palaeozoic Bryozoa of the Baltic Provinces," by R. S. Bassler (United States National Museum, Bulletin 77) is a memoir of three hundred and eighty-two pages, with thirteen plates and two hundred and twenty-six text-figures. The fossils of the Russian Baltic area, found in almost unconsolidated Lower Palaeozoic strata, are renowned all over the world for their abundance and exquisite state of preservation. This work is as complete a study of the Russian Ordovician Bryozoa as the available collections would allow. A single Cambrian form, the oldest known Bryozoan, is described. A digest of the Lower Palaeozoic geology of Baltic Russia is given, and the Russian beds are correlated with their stratigraphical equivalents in North America.

For stratigraphers a work of inestimable value is that just issued by the United States Geological Survey under the title "Index to the Stratigraphy of North America" (Professional Paper No. 71). This important publication has been compiled by Bailey Willis and G. W. Stose, and runs to eight hundred and ninety-four pages. The aim is to summarize North American stratigraphy as fully as the data available and the scope of the work permit. The material includes some discussion of stratigraphy, some citations of fossils, and views on correlation. The work is accompanied by a geological map of North America in four sheets, making a wall-map 60×77 inches, whereon the geology is set out in forty-two colours. In addition the text contains eighteen sketch maps, giving the areal distribution of the combined formations of each system. This is a magnificent piece of work, for which geologists all over the world will be grateful.

Palaeontologists, likewise, will be grateful to the United States Geological Survey for the publication of Dr. Walcott's monumental monograph on the Cambrian Brachiopoda of the world. This is the crowning achievement of Dr. Walcott's lifelong work on Cambrian rocks and fossils, on which he is the foremost authority. Five hundred and thirty-six species and varieties, grouped in forty-four genera and fifteen sub-genera, are described, along with forty-three Ordovician forms. The great bulk of Cambrian brachiopods are inarticulate, phosphatic-shelled forms, and they attained their maximum of specific differentiation in the Middle Cambrian, where there are thirty-one genera and three hundred and fifty-five species. Even in the Lower Cambrian there are thirty-two genera and one hundred and sixteen species, showing that the Brachiopoda must have originated much farther back in time than the earliest fossiliferous rocks. Dr. Walcott concludes that each species is, in general, confined to one type of sediment, and out of five hundred forms only one hundred and fifty have been found in more than one kind of sediment. The "facies" of the rock, therefore, becomes very important in palaeontology, and especially in zonal stratigraphy.

A RIEBECKITE ROCK FROM ARRAN.—Igneous rocks containing the rare soda-amphibole riebeckite are now known to occur in several British localities. The best known is that

of Ailsa Craig, the "ocean pyramid" rising in the middle of the Firth of Clyde, but other types occur at Mynydd Mawr in Wales, in the island of Skye, and in the Lower Carboniferous eruptives of the Eildon Hills, near Melrose. A further example, recently discovered by the writer, is important, since it occurs with much the same geological relations, and only a few miles from Ailsa Craig. The rock referred to forms the great so-called "felsite" boss of the Holy Isle, near Lamlash, Arran. This intrusion rises from the sea to over a thousand feet in a steep pyramidal hill, strikingly similar to Ailsa Craig. The rock weathers deeply to a soft, crumbling, yellowish "felsite"; but on breaking a large block, the interior is found to be composed of a fresh dark-grey rock, which, on sectioning, proves to contain riebeckite. The rest of the rock is built mainly of short stumpy prisms of sanidine, with a few irregular interstitial grains of quartz. The riebeckite forms typical spongy masses, with a characteristic pleochroism from indigo-blue to yellowish-green. The rock is a riebeckite-orthophyre, and differs from that of Ailsa Craig only in its comparative freedom from quartz.

MICROSCOPY.

By F.R.M.S.

QUEKETT MICROSCOPICAL CLUB.—February 25th, 47th annual general meeting. The presidential address on "The By-Products of Organic Evolution," was given by Professor A. Dendy, F.R.S. After referring to well-known cases of by-products in industry, the President thought that nowhere in the animal kingdom is there a more exact analogy than in the familiar rotifer *Melicerta* which builds for itself a dwelling-place out of its own waste-products. The main part of the address was devoted to a consideration of the evolution of the very many forms of sponge spicules from the primitive ancestral form consisting, in the case of the Tetraxonida, of four rays diverging at equal angles from a common centre. The development of the orthotriaene, dichotriaene, protriaene, anatriaene, and discotriaene forms was then traced. An altogether different line of evolution from the primitive tetract archetype appears to have given rise to the typical oxeote spicules of the monaxonellid division of the Tetraxonida. In the course of evolution the distinction between skeleton spicules (megascleres) and flesh spicules (microscleres) becomes very marked. Both had, doubtless, a common origin, but whereas the megascleres are obviously adapted as the principal skeletal elements and are arranged accordingly in the sponge, the microscleres are scattered at random through the soft ground substance and in the majority of cases it is impossible to assign any value at all to their presence. They are, however, so constant and characteristic that they afford by far the most convenient and reliable data for the classification of the tetraxonid sponges. The President had previously suggested that the various forms were determined by differences in the hereditary constitution of the mother-cell, and in our ignorance we may assume that such differences arise spontaneously in the germ-plasm, and that it is a mere chance whether or not they may prove to be of any value to the organism. Or, again, the differences may be due to the permutations and combinations of ancestral characters which take place in the maturation and fertilisation of the germ-cells, or to the influence of some change of environment upon the germ-plasm. If the characters of sponge-spicules are really of the nature of mutations it should be possible in the future to obtain Mendelian results by hybridisation, but we should require to know a great deal more than we do now about the breeding habits and life-history of sponges before we could hope to bring such experiments to a successful issue.

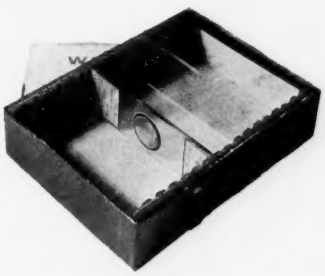

FIGURE 142.

FIGURE 143.

A USEFUL POCKET CASE FOR MICRO-SLIDES.—The microscopist often wants to carry in his pocket a dozen or so slides. It is true that small boxes for holding a dozen or a score of slides are on the market. But one may not be able to obtain these at short notice. Again, it is a convenience to have several of these boxes and those with a limited pocket may be glad to spend a hour or two's time rather than so many shillings.

The two contrivances hereinafter described merely require some pieces of card or straw board, a fairly sharp knife, some fish glue or strong gum solution, and a little patience, for their making, which is a very simple matter.

If the reader is not a photographer he is pretty sure to have the acquaintance of one, from whom he can, for the asking, obtain an empty quarter-plate card-box with lid, and very probably also some fairly stout pieces of yellow straw board, such as is often sent out as packing along with packets of bromide and similar printing papers. The quarter-plate measures four and a quarter by three and a quarter inches, and the boxes are about four and a half by three and a half inches inside, and one inch or so deep.

In Figure 142 we see such a box fitted to carry three-inch micro-slips. First we cut a number of cards one inch long and one-tenth to one-eighth of an inch wide. Next cut two strips one inch wide and four and a half inches in length, *i.e.*, just to fit the inside of the longer side of the box. The short bits are fixed to the two longer pieces with an interspace just large enough to take the thickness of a glass slip easily. This, I find, provides for sixteen slips in a quarter-plate box. As the box is three and a half inches wide, and the slips only three inches long, we have to pack up with extra strips of card four and a half inches by one inch behind each side piece. In my case two pieces of packing behind each stepped piece gave an easy fit. A glance at Figure 142 will make all clear. The triangular object behind the open box containing one mount and one clear glass is the box lid on which the box is resting to tilt it up for the purpose of being photographed.

We microscopists frequently want to lay aside a number of freshly-made mounts in a *horizontal* position to set, or dry. If such a box be set up to rest on its smaller end, we have such a contrivance. Half-a-dozen of these drying boxes (*i.e.*, containing ninety-six slips), tied back to back in pairs with a bit of thread, take up very little room, and can be left on the top shelf of a book-case, thus drying off slides in a few hours.

The second contrivance is, perhaps, a little more trouble to make, but has the advantage of holding the mounts horizontal when the box is laid flat on the table in the usual way. Here, again, we utilise a quarter-plate box. The complete article is shown in Figure 143; the box is shown containing four card trays, each tray carrying four mounts (Figure 144). A semi-circular piece of card is cut away from the centre of one side of the box (Figure 143), to enable one to lift out the trays. To the inside of the lid are fixed by fish-glue two folded-up strips of thick cloth. These form a kind of soft spring pad, which keeps the contents of the box from shifting about when the box is being carried about in the pocket.

A glance at Figure 144 shows that either of the two central

XUM

slips can be got at directly, but if either of those at the ends (right and left) is wanted we have to remove one of those in the centre.

Figure 145 shows one of the empty trays, made thus. First cut the base piece to fit *easily* inside the box. Now lay four plain three-inch by one-inch glass slips, centrally, side by side, on the base piece, and run a pencil line round the lot. Then cut four strips of card (of thickness a trifle more than the thickness of the glasses) of such size as to fit the card just outside the pencil line. These strips will probably be between one-eighth and three-sixteenths of an inch wide, but their actual size will depend on the size of box in use. (Boxes for quarter-plates vary a trifle in inside measurement.) These four edging strips are fixed to the base piece. Then across each of the four corners is fixed on a triangular piece, so that the bottom or underside of the base piece may be safely clear of the cover glasses on the slips.

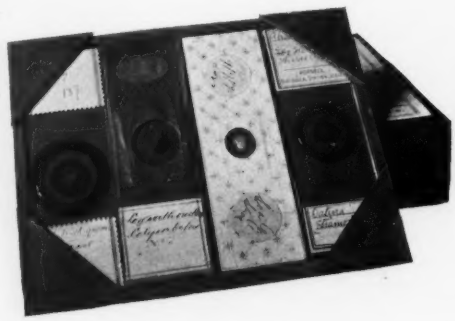

FIGURE 144.

Practical points: (1) Use a sharp knife, preferably one with fixed blade like an office knife. (2) Use a flat metal straight edge for guiding the knife. (3) For cutting on, a piece of card is good—perhaps the best of all things, as it does not blunt the cutting knife point like metal or glass, and the card which is being cut does not slip about. (4) For a fixing agent I vastly prefer fish glue or seccotine. In the bottom of a small wine glass put, say, half a salt spoonful of seccotine, add about one third as much water and work up the mixture with a cheap (penny) paint brush. This is also a good tool for applying the adhesive. (5) When one piece of card has been stuck on to another lay the two together in an old book for a few minutes, to keep all flat until all is fairly dry. (6) Do not use too much adhesive. If any is squeezed out between two pieces of card it is a sign that too much is used. This does not give such a good joint as only just enough to cover the two touching surfaces.

F. C. LAMBERT, M.A., F.R.P.S.

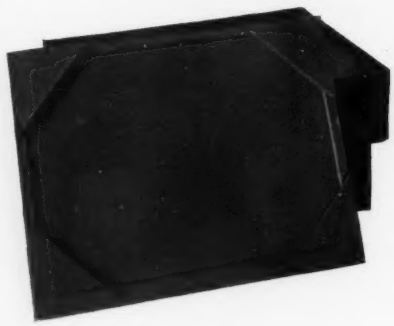

FIGURE 145.

DARK GROUND ILLUMINATION.—It may be of interest to your readers to know that a dark ground illuminator, for use with high power objectives, can be made without grinding away the underside of the top lens, as shown in the piece of apparatus computed by Mr. Nelson in your March issue. All that is necessary, is to place between the top and next lens of the Abbe Illuminator, an opaque disc of such a diameter as will cut off all the rays that directly enter the objective. The simplest way is to take some tin foil and begin by making a disc within a fraction of the diameter of the upper side of the second lens—that is, the lens immediately behind the front lens—of the condenser. This disc is then rested on the upper side of the second lens and made to stay in position by means of a little immersion oil or similar material. The top lens is then screwed on and must be in immersion contact with the underside of the object slide. Now, if a one-sixth inch or one-eighth inch objective be used on the object, which must be mounted in a medium other than air, it will soon be seen whether the object or particles are lit up with a black background. If no light passes, reduce the size of the tin foil disc very slightly and repeat the experiment until the desired effect is obtained. Each individual disc can then be kept for the different objectives and a result equal to that obtainable with the expensive immersion dark-ground illuminators can be secured without expenditure other than that of a small amount of time.

QUEKETTER.

ON THE RELATIONSHIP OF APERTURE TO POWER IN MICROSCOPE OBJECTIVES. — One would have thought that the late Dr. Dallinger had settled the question of the value of aperture once and for all by means of the photomicrographs, Nos. 7 and 8, on the frontispiece to the last edition of Carpenter; but it seems an obsession with some minds to deny the obvious on this subject.

We can pass over Mr. Hutton's references to dilettanti and ignoramuses as opposed to workers and savants and to opticians playing to the gallery, as having no place in a scientific discussion; but he should at least have stated the facts correctly before indulging in such expressions.

He gives the limit of keenness of vision as one hundred and twenty-five lines to the inch because few eyes can measure closer than this unaided. The question is not what the eye can measure or count, but what it can perceive, and most eyes can easily separate lines as close as a tenth of a millimetre. If anyone doubts this, let him observe the scale on an eyepiece micrometer, with this ruling, in ordinary daylight.

He also assumes that no objective will bear more than a ten eyepiece. However true this may be for the highest powers, it increases up to at least twenty, or even twenty-seven, with the lower powers of the same series.

His fundamental error, however, is with regard to the total magnification. The initial power of an objective is always taken for an image distance of two hundred and fifty millimetres, and the image is formed at approximately this distance with the English tube, so that the eyepieces being marked with their actual amplifying power, the total magnification is obtained by simple multiplication. With the continental tube the actual size of the image is only about two-thirds of this diameter, and, to make the result uniform, the eyepieces are marked with only about two-thirds their actual amplifying power—a ten eyepiece being really fifteen—so that simple multiplication still gives the correct total.

Mr. Hutton has given the actual objective magnifications for the short tube; but has taken the nominal figures of the eyepieces as real and has, therefore, worked out his table of apertures at two-thirds of the required figures.

A glance at Professor Abbe's table quoted by him on page 64 of KNOWLEDGE for February will show that the magnifications are given for an image distance of two hundred and fifty millimetres and the list of eyepiece powers given on page 63 are certainly only nominal.

This extra eyepiece amplification with the short tube makes no difference to the quality of the final picture, as the objective image is obviously correspondingly concentrated; but the objective must, of course, be corrected for the tube length with which it is used.

Stated properly, the table becomes as follows with an uniform eyepiece amplification of ten. I have given the necessary apertures for a keenness of perception of both one hundred and twenty-five and two hundred and fifty lines to the inch.

It will be seen that even with an eye of half the usual keenness and a ten eyepiece, the necessary N.A. for a one-

TABLE 31.

Focal length of Objective.	Initial magnification.	Total magnification.	N.A. for 125 lines keenness.	N.A. for 250 lines keenness.
24 mm. or 1 inch. ...	10	100	·13	·26
16 „ „ $\frac{2}{3}$ „ ...	15	150	·195	·39
12 „ „ $\frac{1}{2}$ „ ...	20	200	·26	·52
8 „ „ $\frac{1}{3}$ „ ...	30	300	·39	·78
6 „ „ $\frac{1}{4}$ „ ...	40	400	·52	1·04
4 „ „ $\frac{1}{6}$ „ ...	60	600	·78	1·56
3 „ „ $\frac{1}{8}$ „ ...	80	800	1·04	2·08
2 „ „ $\frac{1}{12}$ „ ...	120	1200	1·56	3·12

sixth inch is well towards what the best makers give, and for a one-eighth inch and one-twelfth inch it is beyond the limit of construction for dry and immersion lenses respectively, whilst for a keen eye we already want an immersion for the one-fourth inch, and with a one-twelfth inch could perceive more than double the structure which it is possible for any cedar oil immersion lens to resolve. For the lower powers a fifteen eyepiece would enable us to use more aperture than any maker has ever offered or could construct in a mount with the society thread. Mr. Hutton's argument that high aperture is futile because the eye cannot use it, therefore, fails completely.

His ideas as to the limit of useful magnification are equally faulty. His formulae with the various denominators ·26, ·13 and ·10 simply mean that eyes with the respective keennesses of 250, 125 and 96 lines to the inch will require magnifications of 577, 1154 and 1500 diameters respectively to define structure as minute as N.A. 1·50 can resolve. There is no need, however, to strain the eyes always up to the limit of perception, and a sensible man will gain relief by using a higher eyepiece whenever the objective will bear it. Thus, a keen eye would require a five eyepiece to see what a one-twelfth inch of N.A. 1·50 can resolve (120 × 5 = 600); but would certainly use an 8, 10 or 12 for comfort. The point as to empty magnification is that the limit aperture of N.A. 1·50 can as easily be given to a one-twelfth inch as to a one-fiftieth inch, and as the eyepiece amplification required for a one-twelfth-inch is only moderate, objectives of higher power are quite unnecessary, besides being more difficult to make and use, and far more costly.

The showing of the beads on *Amphipleura pellucida* has nothing to do with the magnification further than is sufficient to make them large enough to see. The lines usually seen are from 92,000 to 95,000 to the inch, and require only N.A. ·96 to ·99 to resolve them, although they are usually shown with an oil immersion of N.A. 1·3 and oblique light as an exaggerated diffraction effect. I have frequently seen them on what must be a very coarse specimen, mounted in realgar, with the Zeiss apochromats six millimetres for the long, and four millimetres and three millimetres for the short tube, all of N.A. ·95, with a fourteen (actual) eyepiece for the first two and a ten for the last. The images are absolutely identical, thereby proving that the resolution is due only to the aperture; but this specimen cannot exceed 90,000 lines to the inch. The resolution of the beads is a far different matter. The cross lines forming them are, according to the late Dr. Van Heurck, 127,500 to 130,050 to the inch and require in theory N.A. 1·33 to 1·35 to resolve them, so that they cannot possibly be seen with N.A. 1·32 and any magnification. Visibility too, is quite a different thing from resolution with such minute transparent structures, and I believe they have never been demonstrated with less than 1·40 N.A. aided by green light. Dr. Spitta's plate is quite as good an example of fine manipulation as it is of photography.

Mr. Hutton makes another mistake with regard to the resolution given by photography in excess of white light. The thirty per cent. is for the extreme violet and would require a specially constructed objective. Blue light gives only eight and a half per cent. over white, and the eye could perceive the extra resolution as well as the photographic plate if it could bear the intense illumination, or had the cumulative power.

The statement, amongst others, that Messrs. Leitz's photograph at 1150 would give as much as the naked eye at 1400 is due to a misconception. The fact that N.A. 1·32 should give as much resolution with blue light as N.A. 1·43 with white, or rather yellow-green, is probably the statement sought for. The magnification does not affect it.

The fact that some medical students prefer low aperture objectives for their greater working distance and depth of focus is no excuse for decrying so vital a property as aperture on false premises. Those students who take their microscope work seriously and desire to see all the structure there is in their specimens will certainly obtain the highest apertures they can afford in their objectives as soon as they realise that resolution absolutely depends upon it, and will quickly learn to substitute depth of focus by the use of the fine adjustment and the natural accommodation of their eyes.

Nor need either cost or working distance deter them. It is true they cannot as a rule afford apochromatics or even semi-apochromatics, and it is not necessary. First class lenses of high aperture can be bought at ridiculously low prices, and are so near perfection in both performance and workmanship that they are used for everyday work by eminent workers.

A two-third inch of a N.A. ·30 for fifteen shillings and a one-sixth in of N.A. ·82 or an one-eighth inch of N.A. ·85 for thirty shillings each can surely not be called expensive. The first and either of the second will fill the battery for dry lenses as they will each bear high eyepieces, whilst the working distance of the one-eighth inch is fully two-fifths of a millimetre over a No. 3 cover (quarter millimetre) and that of the one-sixth inch a little greater. The student who is clumsy enough for this to be a bar has a lot to learn before he becomes a useful member of his profession, and if forty-five shillings is considered too much to spend on them I should like to know where he can get anything fit to work with for less money. These are by a famous continental firm and he cannot even get the lower apertures better than play-things anywhere for less; but if he prefers English make, any of the first class houses supply objectives of similar aperture and equal performance for a few shillings more.

It is the one-twelfth inch of N.A. 1·30 which is the expensive item; but there is no substitute, and in view of the obvious fact that the corrections and workmanship must be better in proportion to both power and aperture to give a relatively as good performance and the smallness of the work makes it difficult to get them even as good, there does not seem much prospect of cheapening this item.

G. E. GARRARD.

ORNITHOLOGY.

By WILFRED MARK WEBB, F.L.S.

OVEN BIRDS IN THE ARGENTINE. — There is, perhaps, no greater privilege for the naturalist than to wander in foreign parts and observe at first hand the various

FIGURE 146.
An Oven Bird's Nest in a typical situation in the country.

creatures he has read of at home. It was recently my luck to explore some of the little-frequented parts of the Parana, four hundred miles up the river. Among the many interesting objects were the famous Oven Birds, of which there are various species. The commonest (*Furnarius rufus*) is a bird somewhat smaller than a Thrush, of dingy plumage and with a continuous cry. The nests (see Figures 146-148) are placed in the most conspicuous positions—on the cross bars of telegraph poles, window ledges, on monuments in cemeteries, and on posts by the roadside, and I have seen one built in a small back yard on a post to which a clothes line was attached. The clothes fluttering, the woman passing to and fro, the children and dogs playing around caused no uneasiness on the part of the birds. No one ever seemed to resent the intrusion of the birds in apparently inconvenient spots—perhaps the characteristic "slackness" of the people accounts for the fact that the abandoned nests are allowed to remain until totally disintegrated by the weather.

The name Oven Bird is singularly appropriate, the clay nests bearing a striking resemblance to the Spanish ovens in common use throughout the Argentine. The natives call the bird *hornero* (baker), or sometimes *casera*, which seems to mean housekeeper. There are two types of these nests; one kind having a large circular entrance (see Figure 148), the other with the entrance obstructed by a sort of half-opened partition (see Figure 147). The nests are about a foot high and an inch in thickness, and weigh nine or ten pounds.

Lionel E. Adams.

Figure 147.

A Nest of the Oven Bird with a valve-door.

Figure 148.

A boy holding the Nest seen in Figure 146; note the open circular entrance.

PHOTOGRAPHY.

By Edgar Senior.

FADING OF SILVER PRINTS.—Having had occasion recently to look over a number of prints made by various processes some sixteen years ago, and in which every care was taken at the time to make as lasting as possible, such was the condition in which nearly all of those in which silver or its compounds formed the image was found, that we were forcibly reminded of the fact that carbon and platinum are the only really reliable processes for permanency that can be depended upon. It is only fair, however, to mention that those of the prints which were made upon collodio-chloride of silver paper had withstood the test of time and atmospheric influences in a most perfect manner, exhibiting no change whatever that was perceptible. As this want of permanency in prints may be, and often is, a serious matter, one is necessarily led to the consideration as to what are the conditions under which silver prints are liable to fade. It has been stated, and no doubt with a good amount of truth, that the combined bath method is responsible for a considerable amount of the trouble, as these baths usually contain lead salts, added for the purpose of making the toning more regular, and as no amount of washing appears to entirely remove them, the ultimate result is, that the whites of the print become discoloured from the formation of lead sulphide. Without in any way wishing to uphold this method with the combined bath, we must say that prints made upon Lumière's citrate of silver paper, and toned in such a bath, remain unaltered after the lapse of some years, not that this can be taken as a proof of permanency. The question is: are prints made by any particular method liable to fade, and to what extent are they likely to do so? As a test of permanency it has been recommended to photographers to expose a print "in a moist atmosphere" to sunlight for several days when absence of change in colour was to be considered as proof of permanency. This test, at most, is very crude and incomplete, as prints which have withstood it have changed under other conditions. Then, again, many papers will change in colour if exposed to sunlight for a few days, some assuming a yellow, others a greenish tint, and this alteration in the colour must not be mistaken for fading of the print. This latter is brought about by a change in the silver image as the result of chemical action upon it, and must be studied from the nature of the silver print itself. It is well known that although gold, and especially platinum, remains untarnished by any atmospheric conditions, silver, on the other hand, readily becomes coated with a yellowish film of sulphide, due to the presence of sulphuretted hydrogen or more complex compounds of sulphur in the atmosphere, from the products of combustion of gas, the burning of coal, and the decomposition or decaying of organic matter in the presence of sulphates, the action of the hydrogen sulphide upon silver prints in all probability being accelerated by the presence of moisture. Other conditions which would also favour chemical action are increase in temperature, and the state of division of the bodies reacting. And when the photographic image is made up of silver in a fine state of division, we can understand why it is less able to resist the action of such bodies as sulphuretted hydrogen. Then, again, there are many substances which, though having the same composition chemically, exist under several modifications having entirely different properties. Silver is one of these, and this may account for a certain kind of silver image being more permanent than another. In the case of a silver print upon albumen, gelatine, or collodio-chloride paper, the image is probably little more than a darkened organic silver compound, while that on bromide paper consists of metallic silver. This may be seen by examination under a microscope, when the particles of silver will be readily observable, whereas under the same power a printed-out

Figure 149.

A Spanish Mud Oven at Colastine.

image upon silver paper would only appear as a continuous stain. There is, therefore, a great difference between a printed-out image and one produced by development. Then, again, the former is much more readily affected by external agencies, even prolonged soaking in water being sufficient to very considerably weaken them. Then, if the cause of fading be due to sulphurisation, the product formed may be an organic sulphur compound of silver, as pure silver sulphide itself stands the action of reägents very well indeed, and bromide prints toned by means of "Hypo" and alum, "which is a sulphurisation process," are remarkably permanent. It may be remarked also that some bromide prints tone much more rapidly than others, and examination under the microscope shows that those which tone quickly have smaller-sized particles of silver than the others, and this appears to bear out the statement with regard to the state of division of the silver and its influence upon the permanence of the image. If the presence of hydrogen sulphide in the atmosphere is the most destructive agent upon silver prints, then perfect toning with separate baths of either gold or platinum is to be recommended, as a good deposit of these should go far to ensure greater resistance to atmospheric influences. As a test of permanency prints may be subjected to the action of sulphuretted hydrogen for a short time and the action noted by comparison with part of a print not so treated. It will be found that any prints toned with the combined bath will bleach first, then albumen prints, after which gelatino-chloride and collodio-chloride, and, lastly, bromide. There is still one point, however, which has not been touched upon, and that is the influence of the mountant upon the permanence of silver prints. If prints are kept in a damp atmosphere, the mountant may, from decomposition, liberate hydrogen in its nascent state, when, if any "hypo" remained in the print, sulphuretted hydrogen would be formed, with the result that the prints would be affected. This, no doubt, accounts for many prints which have not been mounted lasting longer than those which have, and is an argument in favour of employing a method of mounting in which a material that is not affected by moisture is used. In conclusion we may say, that whatever may be the exact nature of fading in silver prints, sulphur in some form appears to be the prime cause. That collodio-chloride appears less liable to change than some other forms, is the conclusion arrived at from experience, although there appears no theoretical reason why this should be, as the medium itself cannot be considered as making much difference.

PHYSICS.

By ALFRED C. G. EGERTON, B.Sc.

RECENT LECTURES.—The results of physical investigations have been expounded recently by their chief pioneers. It seems the time of year is fitted not only to the planning of new investigations, but the clearing up of past work. Among the most interesting summaries of work accomplished which have lately been given, the lecture by Professor Strutt, at the Royal Institution, on February 28th, finds place. He showed numerous experiments illustrating the phenomena caused by active nitrogen. Active nitrogen is almost certainly nitrogen in the atomic instead of the molecular condition; when the atoms re-combine to form molecules, then ordinary nitrogen is again formed. The transformation of active into ordinary nitrogen takes place with evolution of light of a yellow colour. Such a transformation, contrary to usual chemical action, takes place more rapidly at low temperatures, as was shown in the lecture, by plunging a tube containing active nitrogen into liquid air.

The nitrogen is made active by being submitted to an electric discharge from Leyden jars or similar condensers: ordinary pure nitrogen, freed from oxygen by passage over phosphorus, is sucked through a discharge tube at a pressure of about one millimetre of mercury; the nitrogen, as it leaves the discharge tube, passes into a wider tube, where it can be viewed undergoing its transformation into ordinary form by the yellow light emitted. When other gases, such as chloroform or carbon bisulphide, are passed in together with the active nitrogen, cyanogen is formed and gives out the characteristic pinkish light of the cyanogen flame. The nitrogen, unlike ordinary nitrogen, combines readily with most substances. If the metals are heated gently in the active gas, they give out their characteristic line spectra and form nitrides. Thus mercury was shown to give a brilliant mercury arc effect and form a very unstable mercury nitride, which decomposes explosively on heating.

Now ozone and nitric oxide, when they combine under similar conditions, also give out light, but of a much greener hue, and repetition of experiments on active nitrogen in Germany by certain investigators have been ascribed to the production of ozone or nitric oxide from minute quantities of oxygen contained in the nitrogen. But it must be allowed Professor Strutt has freed his nitrogen from oxygen quite satisfactorily. The active modification of nitrogen can be destroyed by the catalytic action of a surface coated with oxide of copper. A copper wire, coated with oxide, dropped into a tube containing active nitrogen immediately extinguishes the glow. It is necessary for the nitrogen atoms to collide up to seven hundred and eighty times before recombination with another atom occurs, in presence of a copper oxide surface; whereas only one collision of a molecule of ozone against a silver surface is necessary to cause it to transform to an ordinary oxygen molecule. Ordinary nitrogen can be converted into active nitrogen by means of the ring discharge. If the inner coatings of Leyden jars are connected to an induction coil, and the outer to a coil of thirty or forty turns of wire, electrical oscillations will be set up in the coil of wire, which will ionise and induce currents in gases enclosed in tubes at low pressure placed within the coil. Therefore, all that is necessary is to fill a tube with pure nitrogen, at about one or two millimetres pressure, and place it within such a coil, in order to obtain it in the active condition and view the glow given by it.

Another lecturer has gathered together Mr. C. T. R. Wilson's work, which has rendered visible the paths of ionising radiations. When Röntgen rays or the rays from radioactive substances pass through air, they cause ionisation of the air in their path: that is to say, air particles carrying positive and negative charges are formed. Moisture will deposit from air overcharged or supersaturated with water vapour on either dust particles or electrified ions, such as these charged particles are called. Thus, if the air through which rays are passed is supersaturated with moisture, the paths of those rays will be marked by the condensation of moisture on the ions produced in those paths. That is the principle of Mr. Wilson's method of making visible the paths of such rays. However, it is not easy to record such effects photographically: much ingenuity has been displayed in doing this satisfactorily. Mr. Wilson allows the base of the ionisation chamber, containing the moist air through which the rays from radium or the X-rays pass, to drop slightly whereby sufficient expansion occurs to cool the air to the necessary point to cause the moisture to be capable of condensing out on any ions present; at the same time as the expansion chamber base drops a ball is released, which passes between a spark gap, and the spark through a mercury arc gives sufficient light to illuminate the condensed particles, and allow them to be recorded on a photographic plate which has previously been focused on the expansion chamber. The photographs obtained are very remarkable; the paths of the α-rays of radium are very distinct and perfectly straight to within a millimetre or so of their termination, when they often branch off for a short distance at another angle. Presumably, the α-rays have been so reduced in velocity by their collisions with air molecules, that they get deflected out of their path. The results with β-rays —the negatively-charged rays from radioactive substances and the rays produced when X-rays strike against substances —have much more irregular and meandering paths, and the streaks on the photographic plates are much less dense than those due to the α-rays, because the number of ions produced are much fewer. It is indeed wonderful that the actual paths of single particles, of which there are more than a million million million in one cubic centimetre, can be made visible and recorded on a photographic plate; and it is a very

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great feat to have accomplished the actual making visible of phenomena which have only been investigated and understood by process of reasoning; things are understood clearest when they are made to appeal to the visual sense.

Among other lectures of great interest may be mentioned Professor Sir Joseph Thomson's lectures on the Constitution of the Atom, which have just been terminated at the Royal Institution. He expounded in these lectures simply and clearly his view of the atom composed, as all now admit, partly of negative electrons and partly of positively charged matter. The atom possesses a central core of electrons and an outer ring, and the maximum number of electrons in this ring is eight. The number in the ring determine the valency of the atom, and the vibrations (as of a conical pendulum) determine the type of spectra emitted. It would be too much to go into the subject in detail in these notes, and the same also applies to the interesting account of the researches of Professor Nernst, which he expounded on four evenings following the 6th March, to a large audience, at University College, London.

ZOÖLOGY.

By PROFESSOR J. ARTHUR THOMSON, M.A.

A MOUTHLESS CARP.—It seems strange that a fish can live and thrive without a mouth. J. W. Fehlmann describes this apparent simplification of life on the part of a carp four years of age. Its mouth was absolutely shut and the same was true of the anus. Yet there were numerous mayfly larvae, crustaceans, pieces of plants and the like in the food-canal. The animal must have not only breathed but fed through its gill-clefts. We are not surprised to learn that the carp showed no trace of fat, but to live for four years without a mouth was certainly an achievement.

MOVEMENTS OF THE SEA-HORSE.—R. Anthony and L. Chevroton have studied the attitudes and movements of the fascinating *Hippocampus*, which is at once a fish of the floor of the sea (benthos) and "arboricolous" among the sea-weed. It fixes itself upright with its prehensile tail, and is helped by its swim-bladder to keep the vertical position. It swims vertically, or obliquely, using its pectoral fins, and the dorsal fin usually helps. The dorsal fin is also used to steady the animal when it is fixed by its tail. In moving towards an object the sea-horse bends forwards a little and mounts upwards. When it descends it stops the action of its fins. There are many remarkable specialisations about this attractive little creature. Thus there are numerous individualised muscles. The head is not in a line with the backbone, but at an angle of 90°—100° to it.

NATURAL HISTORY NOTES FROM BOLIVIA AND PERU.—Mr. James Murray, who was naturalist on Sir Ernest Shackleton's Antarctic Expedition, now sends some very interesting notes from a very different part of the world—from Bolivia and Peru. The rapidly-dwindling Echoja Indians have great skill in wood-craft. The chief Wahshee could bring the animals to him by uttering certain sounds, which did not seem to be imitations. "On one occasion a deer was sighted. Wahshee began a very loud and wild cry, and the deer came slowly nearer and nearer, till it was only two or three yards from us." "On another occasion it was a black monkey. This time he used a quite different sound, a very plaintive, weird kind of whimpering. The monkey began to climb down the tree towards us, and came quite near before something disturbed it."

MAGGOTS IN MAN.—Mr. Murray gives a grim account of one of the common scourges of the forest, the Sututu (*Dermatobia cyaniventris*), a two-winged fly, whose larvae —about an inch long—occur in the skin of men and beasts. They are like Indian clubs in shape and bear rows of prickles. The presence of the parasite is usually first noticed on account of the sharp pain caused by the prickles as it moves. The chief Wahshee already alluded to seemed to be able to summon the larvae out of the skin by making a curious chirping noise with his mouth, but there is need for sceptical criticism here. Worse than Sututu is the Screw-Worm (*Chrysomyia macellaria*) also the larvae of a horse-fly. Large numbers occur together in the skin about a wound. They burrow restlessly and cause great pain. They kill many mules and a few men, and are themselves singularly difficult to kill. The great specific seems to be a medicament called Cebadilla.

THE SCALLOP'S EYES.—Numerous well-developed eyes occur along the margin of the scallop's mantle, and it is well known that the bivalve is exquisitely sensitive to differences of light and shade. Victor Bauer has made a series of careful observations on *Pecten jacobaeus*, and finds that one great use of the many eyes is to direct the animal to the illumined surface areas, where there is special abundance of the phyto-plankton on which it mainly feeds. The scallop does not steer when it swims, it gets its bearings by means of its eyes before it starts. The eyes also help it to detect the movements of an approaching enemy, and the stimulus leads to a shutting of the shell-valves. The skin secretion of a starfish sets the scallop a-swimming, and here tactile and chemical stimuli operate. But the eyes are auxiliary.

COLOUR-SENSE IN BEES.—Very interesting experiments by L. von Dobkiewicz throw a clear light on a much discussed question and on a number of well-established but discrepant facts. It seems certain that bees distinguish different colours. But different colours acquire significance for bees when the insects have learned that certain colours are associated with certain nutritive advantages. The bees are not "reflex-machines," they are not compelled by any organic chromotropism to prefer certain colours to others. They accumulate experience, and remember that certain colours are associated with certain nutritive benefits. They learn to save time by following certain colour-hints, but it is not inconsistent with this that they are eager visitors of flowers without any colour at all, but rich in nectar none the less.

SENSE OF DIRECTION.—Edmond Bordage made a study of digger-wasps and other insects at Réunion and reached some interesting conclusions. He maintains, for instance, that the wasps find their home again by taking particular notice beforehand of the immediate surroundings. As the Peckhams noticed, there is a preliminary scouting and observation of surroundings before the insect quits the vicinity of the nest. Bordage is unwilling to invoke a special sense of direction in such cases.

OXYGEN-STARVATION.—Anna Drzewina and Georges Bohn have made interesting experiments showing the indifference of many marine animals to scarcity of oxygen. A small shore-crab (*Carcinus maenas*) lived for twenty-two hours in water with only a trace of oxygen, and soon recovered. A pea-crab (*Pinnotheres*) survived for three days. A small sea-anemone (*Metridium dianthus*) lived for four days, and others (*Anthea cereus*) seemed to be quite normal after four and a half. The little periwinkle (*Littorina rudis*) was none the worse for four days of the oxygen-starvation and a Polychaet (*Phyllodoce laminosa*) was living after thirty-nine hours. The little starfish, *Asterina gibbosa*, recovered itself after thirty-four hours. In most of these cases, the animal was inert at the end of the experiment, but recovered in the course of a few hours.

VESTIGES OF SCALES IN SIREN.—It is well known that amphibians are almost always quite naked, thus standing in great contrast to the scaly reptiles. The limbless Caecilians which burrow underground are exceptions, for they have numerous scales embedded in the skin; and there are some other exceptions, such as Ceratophrys, which has bony plates on its back. The extinct Labyrinthodonts were also armoured. In studying the mud eel, *Siren lacertina*, Margarethe Kressmann has made a very interesting discovery. There are numerous papillae in the deeper, firmer layer of the underskin or dermis. They occur over the whole body, and although they are hidden by the more superficial layers of the skin, their structure is such that they are very reasonably interpreted as dwindling vestiges of the scales which ancestral amphibians possessed.

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ON THE FLORAL BLUE.

By P. Q. KEEGAN, LL.D.

THE origin of a colouring matter is technically termed chromogen, *i.e.*, the precursor thereof, or the special chemical constituent, whose presence in the corolla is necessary for its production. Most vegetable colorations are derivatives of what is called the aromatic series of organic bodies, and it is known that as certain members of this series produce the magnificent aniline dyes, whose spectacular effects are familiar in theatres, and so on, so also other members of the same series form the origin of the beautiful tints and hues which clothe the flowers of the field and garden. The floral structures (corolla, sepal, and so on), are built up out of a number of chemical constituents, *e.g.*, cellulose, wax, oil, tannin, mucilage, salts, and so on, which may be withdrawn therefrom and separated by chemical methods. The question arises—a most interesting one to the inquiring mind—what is the particular component of this structure to which is due the outcome of that most enchanting adornment, the blue, red, or yellow floral coloration? We must, by diligent analysis and with inexhaustible patience, turn over every clue; we must test and examine all the constituents, until we find some particular one which unquestionably betrays its relationship to the aromatic series of hydrocarbons aforesaid; for we are assured that therein will lie the true spring and fountain of all this floral glory.

We commence the research naturally by studying specimens of plants which bear really true blue flowers, taking care, of course, that we do not mistake a violet or purple corolla for a really blue one. An astute chemist, who is well versed in the analysis of tannic materials, can foretell where such a subject is sure to be found. He knows that such and such orders of plants—for instance, the Rosaceae or the Leguminosae—do not produce blue flowers, and he can assign a reason therefor. On the other hand, he is quite convinced that certain other orders, such as the Campanulaceae or the Gentianaceae, can assuredly do so, inasmuch as that particular constituent called tannin is of a similar kind in each of the latter two orders, but is widely different from that in either of the two former orders. Which is as much as to say, that a kind of chromogen exists in roses and sweet peas which does not exist in gentians or bell flowers, and *vice versâ*. True blues exist in veronicas, salvias, verbenas, basil, solanum, penstemon, nemophila, convolvulus, borage, hound's tongue, and in all the orders allied to Gentianaceae and Compositae; but not in lupins, vetches, peas, vetchlings, geraniums, hollyhocks, primulas, balsams, flax, and so on. In the blue flowers just mentioned there is a chromogen, *i.e.*, a tannin common to all as detected by chemical analysis, whereas in the non-blues this special substance does not occur. A noteworthy fact or peculiarity is that while one series or order of plants containing this special colour-producing body may exhibit red or blue flowers only in certain species or even in one and the same plant, another series or species with the same chromogen evolves nothing but red or yellow adornments. In fact, in some cases—as, for instance, in begonias—a genus may be quite capable of displaying an azure appanage, but its powers are confined to that of red.

However, to come to details, it may be mentioned that the parent substance of the blue flower is called caffetannin and is imbibed in every cup of coffee we drink, whereas when we drink tea we merely absorb something concerned in the production of red camellias, for example. The chemist will inform you that caffetannin exists in somewhat different forms, and has a different composition, perhaps, in different plants. Some say it is a glucoside; others deny that; and some others again assert that it is a mere mixture of organic acids and other substances. What is beyond question is that it contains in its composition (molecule) more of what are called hydroxyl groups than perhaps any other tannic compound known; that is to say, that where an atom of hydrogen might be found, an atom of oxygen takes its place. Oxygen is an element essential to the support of animal life, but it is also a supporter of coloration, yellow for less of it and blue for more of it. Moreover, we can artificially produce a blue compound from caffetannin; but from any other kind of tannin save one, this cannot be done. We have only to leave a solution of caffetannin freely exposed to the air with a little chalk added, when we see the latter gradually turn green, and then on pouring off the liquid and adding some acid, a red solution is obtained very like the tint of the foxglove corolla, and so on, and which, like it also, may by a certain treatment be changed into a brilliant blue. By a careful application of dilute solutions of an iron and a sodium salt the dilute colourless solution of the same tannin can also be induced to yield a most beautiful and persistent azure liquid.

In fact, the complete analysis of any plant that contains this tannin reveals in many ways that we are dealing with a powerful colour-evolving substance. Then again, we observe similar phenomena repeated when other plants, perhaps belonging to widely different classes or orders, are taken in hand. But however wide these taxonomic differences, we find invariably one common feature, *viz.*, the capacity to produce a true blue flower. Moreover, this most remarkable feature is absolutely independent of the status of the organism, of the organic perfection or degradation of the species. The gentians, for instance, with their feeble powers of assimilation and their mycorrhiza infestation; the Compositae deprived of one at least of the chief factors of organic perfection; the Labiates more perfectioned than the borages or the solanums; the Ranunculaceae, Liliaceae, and so on, with types representative of a special kind of organic debasement—all these and more rise to the same high level of floral glory when they unfold and hang out to sun and shower the "soft eye-music" of the flaunting blue.

In fact, the blue corolla is caused by the comparative strength and completeness of the process of de-assimilation occurring there, and this, no doubt, is also the cause why in some plants a certain kind of tannic chromogen is produced, and not so in others. The protoplasm, in order to eliminate from its molecule a tannin containing six HO groups, would de-assimilate or oxygenise more completely than if it produced a tannin with only four or five HO groups. Also, in Gentianaceae with very numerous ovules, blue flowers of the most brilliant description are frequently exhibited; in Compositae with only one ovule they are comparatively rare and never so effective. In the latter case, the de-assimilation is not complete, various volatile oils, resins, and tannoids being a common outcome of the process. It may occur, of course, that the plant itself may produce in its green organs a large quantity of caffetannin—for example, the common yarrow—while the flowers are white or pale pink; but this apparently does not occur in plants with vigorous powers of reproduction (*e.g.*, gentians) wherein tannoids only appear in stem, leaf, and root, the more complete and final products being found exclusively in the floral parts. Therefore, in accordance with this report herein set forth for the first time in this journal, let gardeners cease from troubling to "evolute" a pure blue flower on a plant incapable of constructing a tannic chromogen containing less than a certain number of hydroxyl groups.

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THE NEGLECT OF METAPHYSICS.

By J. E. CAIRNS, B.Sc.

THE latter half of the nineteenth century beheld a startlingly sudden advance of science unparalleled in the history of the world before; a true Scientific Renaissance. It was the publication of "The Origin of Species" which probably pulled the trigger and released the vast stores of energy which threatened to change completely the face of the world; but the mines had been laid long before, and the time had at last grown ripe for their discharging. The world called for men and the men came. In biology, chemistry, physics, psychology, giant intellects sprang to the fore; discovery followed discovery, theories were conceived only to be supplanted before their birth, and the array of new facts grew so amazingly that the mind was stunned and bewildered before the dazzling display of treasures that were heaped before it. Though confounded at first by its "sudden joy," the mind soon took on a somewhat calmer mood in which it could appreciate its new riches, and it conned them over and over again with ever-widening and ever-deepening delight, till at last the wild excitement of attainment gave place to the wilder excitement of possession. Then ensued a period of what to us now appears like intellectual debauchery: a time of rash assertion, of bitter controversy between those who were conceited with their knowledge and those who were conceited with their ignorance; a pitifully hysterical display of *nouveaux riches*, a cruelly uncompromising attitude of oracularism.

In those days—they seem so long ago, though in truth so recent!—one heard on every hand the stupendous promises of science; that it alone was capable of explaining away all the problems of the Universe, and that it would make for mankind a bed on which to lay his perplexed head in peace,—a hard bed perhaps, but surely preferable to the soft "pillow of obscure ideas" on which he had dreamed so restlessly so long! Science was rapidly assuming the rôle of the fairy-godmother, that unworthy rôle which Huxley so bitterly deprecated.

So it was then; and now, at the beginning of the second decade of the twentieth century, what has it all come to? the sweat of the conflict, the paeans of the victors, the woe of the vanquished—what has come of them all? For now the struggle is over, save for some inconsequential skirmishes that still go on among those who have not yet realised that the whole war was but the striving of phantoms over a shadow; it is over and forces have been reviewed, losses told and trophies counted. And here both sides have found that their losses proved to be their gains, and their trophies were so stained with the marks of meaner passions that they were ashamed to vaunt them. But what of the grandiloquent promises that science made to its partisans? Have these been redeemed, and are the great world-riddles all answered?

We know now the promises were vain; the boasted omniscience but the empty wisdom of intoxication. The phase has passed, and now we know that science has not answered, and cannot answer the clamouring questions regarding human destiny. Soul, mind, consciousness—death, immortality, God,—of these, the physical science that has spoken so loudly for itself knows nothing. Indeed, it has not even a satisfactory criterion of reality to apply to the subject-matter of its own studies; it assumes reality where it knows only appearance. These other vitally important questions it cannot in the very nature of things hope to answer, and they are left to a few enthusiasts whose feeble voices have been almost drowned in the swelling triumph hymn of their brothers in the physical camp. There are aspects of the universe which are not amenable to investigation by retort, microscope or galvanometer, and this the physicist must remember and thereby calm his too-arrogant enthusiasm.

Let us enquire for a moment into the grounds for this enthusiasm of the scientific man—always meaning by that term the student of the physical or material aspect of the universe. At first sight these seem very solid, and the enthusiastic assertions quite justifiable. We think of the theory of natural selection; of the discovery of radio-activity; of the hypothesis of the electro-etherial constitution of matter; and the thrill of intellectual satisfaction we experience shows us that these things are good for man to know. We remember wireless telegraphy, X-rays, the transmutation of the elements, the possibility of utilising the almost infinite stores of energy that is within the atom, and science becomes the fairy-godmother again.

We cannot praise too highly the genius and the patience of those who have learned these things from nature and given them to man. The splendour of the results achieved by modern science is fully appreciated by us all, and to the modern scientific man all pay their homage. It is when he is raised to be a brother of the gods, with his fingers on all the springs that direct the cosmos, that justifiable enthusiasm degenerates into rank hysteria.

For in these results, which as records of human ingenuity are so splendid, no really vital interests are touched. True, the idea of unity and of beautiful inter-dependence which they give reflects back on our moral life and influences our conduct; but it is only a reflexion, not a direct effect. They have made the great mysteries of the whence? the why? the whither? no clearer; and these are for mankind the real vital questions, to which the nature of Nature is only an embellishment.

The value of the work that has been done in science none can gainsay, but it sinks into comparative insignificance before the value of the work that has not been done. For mankind, the study of the physical universe is of great importance, but still its importance is only secondary to the knowledge of the things that are not seen but are eternal. Not that we want a Comte of the spiritual, obstructing all knowledge save such as seems useful. It is a conceited presumption that pretends to be able to demarcate useful from useless knowledge. Our insight—especially of us physicists of the West—is not sufficiently clear to justify such a position. Yet at the same time, while not absolutely decrying any knowledge, we may easily see that some things are of more importance to mankind than others are. And here is the parting of the ways; this is the question that splits the company, the question that Herbert Spencer asked explicitly, and every other philosopher asked implicitly—What knowledge is of most worth?

Spencer answered this question to his own satisfaction by the single word—Science! This was, without doubt, the true answer for the time. Science was then the knowledge of most worth, it was the knowledge the world needed most. But it is not the true answer now. The world has had its science, and has thriven upon it; but now, after a gorgeous feast, repletion is approaching.

Science is growing stultified and engendering stultification. Having neglected things of the spirit and concentrated its attention on matter and force, it has become "of the earth, earthy." Man is growing dissatisfied with the description of himself in terms of chemical equations and mathematical formulae, and nothing more. He *knows* there is something more, and consequently is annoyed when his darling science persistently ignores it, and sometimes denies it. And, as well, there is a rankling vindictiveness against this science, which cut the wings of his airy fancies thirty or forty years ago, and left him to crawl along the ground since.

There is a feeling of unrest, of incipient rebellion; a stirring of resentment against the salt that has lost its savour. The very men of science themselves are casting about after wider things.

If we look plainly at the fact then we must admit that science has failed. It has given us a world without a God, a

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body without a soul, a life without an objective. But at the same time we must also plainly see that this failure is not due to science in itself, but to the extravagant claims that were made in its behalf. It was thrust into the giant's robe, and could not help but trip over it. It is rather remarkable to think that the necessarily restricted range of physical science was lost sight of by its most gifted exponents. The rule of the game (so to speak) which arbitrarily assigned matter and energy alone to scientific activity, neglecting any other forces or entities that might exist beyond these—this rule was forgotten by the very players who imposed it. After thus consciously and willingly setting limits for themselves, they went on to declare—some openly, some tacitly—that these limits included the whole contents of humanity's intellectual aspirations! All that science could teach was all there was to know!

The enormous success that resulted in this limited field is the only extenuation—and a very poor one it is—for such conduct. The scientific men in their sparkling progress hustled a wondering world along with them, and for a time all forgot that science represented only one aspect of this scheme of things, and that the less important aspect.

But only for a time. The pace is now slackening and cooler judgment is returning. The problems that science *cannot* solve are coming forward once more, as they always must do, to the front. Science must vindicate itself for solving the world-riddles in terms of a godless universe, a soulless body, an aimless life! And science is dumb and helpless.

It is not difficult to see, however, that had physical science been supplemented by metaphysics, as it should be, this *impasse* would not have been reached, but all the unanswerable questions which are now clamouring for answers would have been taken to the metaphysists whose business it is to answer them, For science has solved its own legitimate problems, and solved them brilliantly; it is only with the problems of metaphysics that it has failed.

It would seem, then, that for us the knowledge of most worth, the knowledge that we need most to study, is metaphysics. The laws of the inter-relations of matter and energy we know fairly thoroughly; but what constitutes reality; the nature of the Soul and God; the influence of Mind on Matter—we understand hardly at all, when we need so much to understand them. These latter should be—must be, now!—the subjects of human investigation; and the results when combined with our existing and ever-growing knowledge of things physical will give us a conception of the Universe far more likely to satisfy both the emotional and the intellectual cravings of man than any extension whatever of our science of to-day could do.

And in this investigation it would be well to remember that there are in India and China peoples who have been studying these matters for at least twenty thousand years. Their science was hoary before ours was born. It is for the twentieth century to witness the meeting of East and West in scientific brotherhood, on terms of mutual instruction.

Let us then turn to the East whence cometh the light!

CORRESPONDENCE.

AN IDEAL MUSEUM AND ITS GUIDE.

To the Editors of "KNOWLEDGE."

SIRS,—I feel somewhat relieved to learn from the letter signed by Mr. Francis Guy Laking, M.V.O., F.S.A., the Keeper and Secretary to the London Museum, Kensington Palace, which appears on page 93 of your March issue, that he is in no way responsible for the guide. As you, Sirs, rightly pointed out in your note, I had already made this clear in my contribution. I must, however, express surprise at the fact that the guide was never submitted to the authorities, and, in the circumstances, still greater surprise that these authorities yet permit the out-of-date, inaccurate, and misleading guide to be sold at the museum to the public, especially as these authorities are not enveloped in the "entangling meshes of departmental red tape." I know of no provincial curator who would permit this, and I am sorry to learn that the Keeper and Secretary of this important London Museum is not able to prevent it.

I thought I had also made it clear that I was not misled by the so-called guide, but my remarks were based upon an actual examination of the cases and their contents. I feel flattered and gratified at being asked to give any suggestion for the improvement and the arrangement of the specimens in this important museum, and will certainly accept the kind invitation to call upon the curator the next time I am in town.

A PROVINCIAL CURATOR.

THE FOURTH DIMENSION.

To the Editors of "KNOWLEDGE."

SIRS,—Mr. H. Stanley Redgrove, in a letter in your February issue, expressed surprise that I did not go into more detail in my reply to his statement that the existence of one dimension implies that of a second, a second that of a third, a third that of a fourth, and so on. I mentioned what experience tells us in reference to dimensions, and pointed out that there is nothing in this experience to support his statement. In his letter in your March issue—in reply to the letter of Mr. Henkel—he gives his argument in more detail, so it is possible for more criticism to be made. He asks what can be the criterion of real existence which denies reality to that which exists in mind. A single dimension has no real existence in mind; only the idea of it exists in mind. Our knowledge of the real existence of anything must be based on experience, and we have no experience of one dimension except in conjunction with the other two. When the mind thinks about one dimension it singles out one thing from its experience and directs its attention exclusively to it, but this action of the mind—or the idea in the mind—does not give the one dimension any independent reality, or give any support to an argument that the one dimension has independent reality. In reference to his statement that nobody has ever seen a three-dimensional body, it may be said that though any single perception cannot give the knowledge of three dimensions, there are very many perceptions—of various kinds—and the accumulated result is experience. Certain kinds of inductive reasoning—as exemplified in his letter in your February issue—may be of use when finding out algebraical laws, but it is a very different thing when it is a case of finding out what is, or is not, in real existence. His statement—in the letter mentioned—that the existence of n dimensions implies the existence of $n + 1$ is of the same nature as a statement that if there are 50 sheep in a meadow there must be $50 + 1$. There is no evidence in favour of the real existence of the fourth dimension and no evidence against this.

HENDON, N.W. JOHN JOHNSTON.

FOURTH DIMENSION.

To the Editors of "KNOWLEDGE."

SIRS,—I do not wish to enter on a controversy with Mr. Redgrove as to the nature of reality, for I am inclined to sympathise largely with much of what has been said and written, and the matter is one about which philosophers have always differed, and I suppose will always differ, from the days of Plato to those of Bergson (who by the way owes much to the former, though he does not acknowledge his debt to any great extent). As a "working definition" perhaps one might tentatively define reality as that which exists independently of any human mind perceiving it, as we conceive the "material universe" to do.

With regard to our *seeing only* flat surfaces apart from the stereoscopic effect arising from our two eyes, I would assert that without *some depth* (*i.e.*, third dimension) no surface whatever would be visible. The nearest approximation, optical images and excessively thin sheets of metal, to be seen by me or even distinctly conceived in my mind must have some thickness as well as length and breadth, though the third

dimension *may be as small as we please* by comparison with the others. Moreover, it is a matter of convention *which* we call x, y, or z, but a fourth dimension cannot be interchanged with any one of the others, any more than can the time element (one-dimensional) be exchanged for it or them.

"The phenomena whose study is the object of Natural Philosophy take place each at a definite location at a definite moment, the whole constituting a four-dimensional world of space and time" (Whittaker's "Aether and Electricity," pages 447–8) and a method of *analysis* may be (and has been) devised, dealing with the theory of the aether and other matters.

But the essential nature of the one-dimensional element, time, is in thought at least so different from that of the others that nothing can be inferred from this as to the existence of a fourth dimension of *space*.

Bodies move in *space* and require *time* to do so; perhaps, after all, our *knowledge* is confined to *moving objects*, time and space being more or less necessary mental concepts. Then the number of dimensions we adopt for each is a matter of convenience, the *fewest* necessary and sufficient to adequately *describe* phenomena.

F. W. HENKEL.

THE JOURNAL OF ECOLOGY.

WITHIN the next few days the first number of a new natural history journal will be published—*The Journal of Ecology*—which will be primarily the organ of the British Ecological Society. The proposed formation of this Society was mentioned in an editorial note in "KNOWLEDGE" for February, 1913 (page 56), and has met with such a hearty response—not only from botanists but from others, both in this country and abroad, interested in Natural History in general, including Zoölogy, Geology, Geography—that it has been found possible to extend considerably the originally proposed scope of the Journal, and at the same time to issue it at a moderate price.

The Journal of Ecology will be published quarterly (March, June, September, and December), at an annual subscription of 12s. 6d., post free to any part of the world. This subscription carries with it the privileges of Associateship of the British Ecological Society, including the use of a library of ecological works which is being formed, the answering of enquiries addressed to the Secretary of the Society, the right to attend the indoor and outdoor meetings, which it is proposed shall be held at different centres in Great Britain, and participation in other advantages which are offered. The membership subscription is one guinea, entitling the subscriber to receive the Journal and to other associateship privileges, and in addition to vote for, and serve upon, the Executive of the Society, and to assist in shaping its policy and directing its activities.

The first number of *The Journal of Ecology* contains eighty pages, and includes many and varied interesting articles.

The Editor has taken a wide and generous view of the scope of Ecology—briefly stated, this embraces everything connected with the relation of plants and animals to their surroundings. So far as the animal kingdom is concerned it is proposed at first to confine Animal Ecology to such topics as the inter-relationships between plants and animals—in itself a large field—but it is recognised that, logically, it is not possible, nor is it desirable, to confine the concept of Ecology to *plant* ecology as is usually done. In the present, as in the past, the distribution and migrations of plants and of animals over the earth are in many respects closely bound up with each other, to say nothing of the many special cases of mutually beneficial partnership (symbiosis in the wide sense) and of other forms of interaction between the two kingdoms of Organic Nature.

Following an introductory article stating the aims of the new Journal, Professor F. W. Oliver, F.R.S., contributes an interesting account of the vegetation of the new Nature Reserve at Blakeney Point—the remarkable shingle beach (see "KNOWLEDGE," January, 1913, page 1) and other habitats in this locality now secured as a refuge for an unusually rich flora and fauna—with remarks on the influence of the animals upon the vegetation, Mr. Wilfred Mark Webb, F.L.S., F.R.M.S., gives a useful and encouraging summary of the progress which has been made, and the organisations which are now in existence, towards the making of Nature Reserves in this country—while the Editor reviews a number of recent foreign publications regarding Nature Reserves in various parts of the world. Dr. W. G. Smith writes concerning the work of Raunkiaer on "biological types" or "life-forms" of flowering-plants and their distribution—thus bringing to the notice of English readers, for the first time, some of the most fertile and interesting new ideas and points of view that have been introduced into the study of plant-life during recent years; this article will be of special value to field botanists, and will indicate a fascinating line of work which they can well take up with pleasure and profit to themselves and with every probability of contributing usefully to the general knowledge of plant distribution and adaptation. Mr. A. G. Tansley, M.A., F.L.S., reviews the recent attempt of Drs. Brockmann-Jerosch and Rübel, two distinguished Swiss botanists, to draw up a general classification of plant communities, criticising certain aspects of the scheme proposed by them and giving details of the various communities. Mr. Clement Reid, F.R.S., and Mr. W. B. Crump, M.A., contribute articles originally read by them before the British Association, the former dealing with the relation of the present plant population of the British Isles to the Glacial Period, the latter with the ecology of moorland plants and the phenomena of wilting in plants generally.

In addition to these articles, occupying the first half of the number, there are numerous other articles based upon recent work published in this country and abroad, dealing with Ecology in the wide sense and including plant distribution, the study of individual plants and of plant communities, the anatomy and physiology of plants where the facts discovered bear directly upon the relation of plants to their environment, nitrification and other aspects of soil-study, experimental morphology, and so on. The Editor has succeeded in making these review-articles thoroughly readable and easily intelligible to general readers with little or no special knowledge of botanical science—this is perhaps especially the case with those dealing with coast, woodland, marsh and desert vegetation, and the biology of cushion-plants, of insectivorous plants, of heather, and so on—while at the same time these summaries of recent work will prove useful to botanists and even to those themselves engaged in research work in plant ecology and biology. Teachers, for instance, will find such articles as those on desert vegetation, the glacial floras of Europe, as well as those dealing with British vegetation, of the greatest interest in connection with the teaching of geography as well as nature study.

The editor of *The Journal of Ecology* (Dr. Cavers, Goldsmiths' College, London, S.E.) is also secretary of the British Ecological Society, and information regarding the Society may be obtained from him. Subscriptions for the Journal with Associateship (12s. 6d.) or with membership (one guinea) of the Society should be sent to the Cambridge University Press, Fetter Lane, London, E.C.

The number concludes with extensive lists of recent literature on Ecology and cognate branches of study, and in a list of "forthcoming attractions," inserted in this number, we find promise of some interesting contributions which will appear in subsequent numbers of the Journal. A special feature will be a series of articles dealing with methods of ecological study, which should prove of great value to those wishing to take up this interesting line of study, since the articles will be written by well-known botanists who have specialised in the subjects with which they will deal.

REVIEWS.

AERONAUTICS.

Aeroplanes in Gusts—Soaring Flight—and the Stability of Aeroplanes.—By S. L. WALKDEN. 184 pages. 4 folding plates. 8½-in. × 6-in.

(E. & F. N. SPON. Price 7/6.)

We have heard and read much about the stability of aeroplanes, some that is good and much that is bad; but in almost all cases the stability considered is that of the aeroplane in *calm* air, a condition in which it does not much matter whether the aeroplane is stable or not, so long as the control is easy.

Furthermore, the cases considered are those of machines in which the surfaces bear definite inclinations to one another, and retain definite shapes: that is, the whole machine is rigid; but Mr. Walkden opens up a far wider field with countless possibilities, by considering the case of the non-rigid machine which has a certain amount of elasticity introduced into its construction.

The author breaks fresh ground in the very first page and continues to do so throughout the book. To start with, a gust is defined and it is shewn that the proper and scientific measure of a gust is "the acceleration of headway" impressed upon the flying machine, the word "headway" being used in place of the cumbersome but more general expression "velocity relative to the air." The use of this as the measure gives us a well-ordered explanation of all the questions connected with stability, stresses, and soaring flight in disturbed air.

Throughout the book, pretty graphical methods are adopted for displaying the author's arguments and results. Following on a very complete analysis of gust effects, comes a fascinating treatment of the problem of Soaring Flight. Many a reader will look upon "ascending currents" as the only possible explanation of soaring flight, but Mr. Walkden clearly demonstrates that there are many other and commoner conditions of the atmosphere capable of being utilised by a bird, if not at some future date by a machine. For this purpose, for example, what the author terms "Wheeling Soaring" can be effected by making use of horizontal gusts, or even of large horizontal whirls. That such gusts do always exist and that Mr. Walkden's figures are quite ordinary, will be recognised by anyone who has watched the motions of an up-to-date wind-velocity recorder, which will shew that in any wind there is, say, twenty or thirty times a minute, a variation of perhaps from twenty per cent. to fifty per cent. on either side of the mean.

This may serve to shew the new and instructive matter that is to be found in Mr. Walkden's book. The whole arrangement of the book is of the same high quality as the contents; it is well printed, with a very complete index, and the plates are arranged so that they can be studied while reading without turning back the pages. We congratulate Mr. Walkden on this addition to science.

T. W. K. C.

ASTRONOMY.

Astronomy.—By G. F. CHAMBERS, F.R.A.S. 335 pages. 350 illustrations. 8 coloured plates. 6½ × 4½-in.

(Hutchinson & Co. Price 5/-.)

Mr. Chambers is very well known as a writer of astronomical handbooks. The present work is intended for "the man in the street" who desires a speaking acquaintance with the subject, without going into any abstruse questions. In one respect the book may be unreservedly commended, *viz.*, its illustrations, which are excellent; they include some recent photographs of comets and nebulae, and planetary drawings by Antoniadi, Phillips, Bolton, and so on. It is a little disappointing in the text to find the very important astronomical progress of the last twenty years passed over so briefly; most of the book might have been equally well written thirty years ago. There are also not a few inaccuracies. Thus on page 56 we have the old suggestion that the numerous satellites of the remote planets compensate for the diminished sunlight, though it has often been shown that the combined light of Jupiter's or Saturn's moons falls far short of the light of our Moon. On page 59 the axial poses of Venus and Neptune are almost certainly erroneous. The latter is the pose of the satellite's orbit, which is inclined some twenty degrees to the primary's equator. Page 62, line 17, for axis-minor read major. Page 64, the daily distances travelled by the planets ought all to be doubled. Page 73, the light of Venus at maximum is said to equal that of Sirius; it is really some fifteen times greater. Page 83, Deimos, Phobos are generally taken to be the attendants of Mars, not his steeds. The original (Iliad XV, 119, 120), perhaps admits either interpretation:

> Ὣς φατο, και ῥ' ἵππους κελετο δειμον τε φοβον τε
> Ζευγνυμεν, αὐτος δ' ἐντέ ἑδυσετο παμφανοωντα.

Which Pope translates—

> With that he gives command to Fear and Flight
> To join his rapid coursers for the fight.

Page 84, line 5, for Venus read Mercury; line 12, for five thousand read four thousand three hundred. Page 90, line 26, for one hundred and ninety-four thousand read one hundred and eighty-six thousand three hundred and twenty-six; line 32, for 60″ read 46″. Page 106, the words about the suspected ring of Neptune and the guarded language about the existence of the satellite might have been written about 1850; they are ludicrous now. Page 118: it is misleading to say that the Saros brings back solar eclipses to the same regions after eighteen years. The region is shifted 120° westward, but in the case of eclipses near the poles the two tracks may overlap. The tracks are said to move southward after a saros; this is only true for ascending-node eclipses; in descending-node eclipses, of which 1914 is one, they move northwards. Page 128, the shadow in 1914 travels from Norway to Russia, not *vice versa*. Same page, the map in Oppolzer's "Canon of Eclipse" is quoted as evidence that the eclipse of 1999 will not be total in Cornwall. But the maps in the Canon only represent tracks of eclipses as circular arcs, which do not claim to be accurate. Calculation shows that the eclipse will be total in Cornwall.

Page 195 footnote, Sigma Octantis is stated to be some distance from the south pole; it is really only three-quarters of a degree distant, much nearer than our Pole Star. Page 200, no mention is made of the very important double-star work done at Greenwich. Page 214, the eclipse theory of Algol is no longer merely a suggestion, it is demonstrated fact; the secondary minimum, when the fainter star goes behind the brighter, has been detected by Stebbins. Page 232, the phrases "White" and "Green" nebulae, objected to by the author, are used to denote a very real difference of spectrum. Page 323, axial rotation, for days, hours, minutes read hours, minutes, seconds. It seems rash to give the short rotation periods of Mercury and Venus without query, considering how many astronomers support the long periods. Curiously enough, the Canadian Handbook noticed below gives the long rotation periods without question. The safest attitude seems one of suspended judgment, the evidence being conflicting. Page 324, the period of Jupiter VII should be 260 days, of Jupiter VIII 738·9 days, not twenty-six months.

In conclusion, we may state that the chapter on the construction of a small observatory is written with practical experience, and is likely to be very useful.

A. C. D. C.

XUM

The Observer's Handbook for 1913.—72 pages. 7¼-in.×5-in.

(Toronto: The Royal Astronomical Society of Canada. Price 25 cents. (1s.)

A very convenient handbook, containing the same information as our monthly "Face of Sky"; also sunrise and sunset tables for latitudes forty-four degrees to fifty-two degrees, and an article on the Comets of 1912. In the table of elements, page 53, there is a bad misprint. The mass of Mercury is given as 0·476 of the Earth's; this, presumably, should read 0·0476. On the same page, see the remarks in the previous notice *re* rotation periods of Mercury and Venus. Page 54, the periods of Jupiter VII and VIII should be two hundred and sixty days and seven hundred and thirty-nine days, not two hundred and sixty-five, and seven hundred and eighty-nine days. It is curious how often early approximate values of constants continue to be printed, when later ones are readily accessible. Same page, the satellite of Neptune is stated to be nameless; many authorities now use the name Triton, the adoption of which seems worthy of encouragement. The work also contains star maps, with notes on the objects of interest in each constellation; also an article on "Recent Progress in Astronomy," by W. E. Harper. This deals more particularly with stellar parallaxes and proper motions and star-drift. Some recent conclusions in these fields have an important bearing on the structure of the stellar system.

A. C. D. C.

BOTANY.

Hutchinson's Popular Botany.—By A. E. KNIGHT and EDWARD STEP, F.L.S. Volumes I and II. 588 pages. 721 illustrations, 18 coloured plates. 9¾-in.×7¼-in.

(Hutchinson & Co. Price 7/6 per volume.)

These two volumes should do much to encourage the study of plants. They contain a great number of attractive photographs, many of which have been taken by Mr. Step, but it is obvious that there are many details which can much more easily and effectively be brought to the notice of the student by means of a drawing or diagram; and it must be said that those by Mr. A. E. Knight which have been introduced serve their purpose extremely well and are most clear. Mr. Step's books are well known and appreciated, and it goes without saying that he has brought forward in a most pleasing way a multitude of points of interest with regard to flowering and other plants. At the same time, the book is a serious one and contains much valuable information. The structure of the plant, the way it does its work, and the relation of the leaf to its environment, make up the first part; while floral forms and their connection with the visits of insects, fruits, and some account of the reproduction of ferns and mosses, go to make up the second, which also contains a glossary of botanical terms and an index. It appears that at the present day the British public demands coloured plates, and nine very effective ones have been introduced into each of the volumes. We sincerely wish Mr. Step's work the success which it deserves.

W. M. W.

CHEMISTRY.

Elements and Electrons.—By SIR WILLIAM RAMSAY, K.C.B., F.R.S. 173 pages. 7-in.×4½-in.

(Harper & Brothers. Price 2/6 net.)

This little volume gains an added interest from the recent discoveries of Sir William Ramsay, Professor Collie and Mr. Patterson, which indicate the possibility of building up elements from the immaterial ether and transmuting them into one another. These discoveries, in fact, add a further chapter to the history of the atomic theory.

The outline of this history is here given so clearly that even a reader without any previous knowledge of chemistry could follow it. Starting with a brief description of the notions of the ancients about matter, the author soon brings his story to the atomic theory of Dalton, which during the last century was practically unchallenged. It is true that speculations upon the possible existence of a primordial form of matter inevitably followed the discovery of the remarkable periodic relationships among the elements, but it was not until the disintegration of radium into other elementary bodies was discovered that any definite proof was obtained of the existence of something more elementary than the "elements" as defined by the chemist.

Sir William Ramsay keeps modestly in the background while sketching the wonderful discoveries of the last few years, but the story gains much in interest from being told by one who has helped to shape its course.

C. A. M.

Second Stage Inorganic Chemistry (Theoretical).—By G. H. BAILEY, D.Sc. Revised by H. W. BAUSOR, M.A. Sixth Impression. Fourth Edition. 544 pages. 109 illustrations. 7-in.×5-in.

(The University Tutorial Press. Price 4/6.)

The fact that there has been a demand for yet another edition of this book is a proof that it supplies a want. In fact, as a skeleton outline of all the principal facts of which a knowledge is required by candidates for the lower examination in "Inorganic Chemistry," conducted by the Board of Education, it could hardly be surpassed. Moreover, the information is conveyed in such a clear-cut form that it impresses itself upon the memory. The book should prove useful not only to those studying for particular examinations, but also to all students who need a general summary of the principles of chemistry upon which they can base their further reading. Hence, in a way, it may take the place of a course of lectures, provided that it is regarded, like the lecture, as a means of clarifying acquired knowledge. Unfortunately, this type of book also shares with the lecture the danger of being regarded as a thing sufficient in itself.

C. A. M.

Second Stage Practical Inorganic Chemistry.—By WILLIAM BRIGGS, LL.D., M.A., and R. W. STEWART, D.Sc. Revised and enlarged by H. W. BAUSOR, M.A. Sixth Impression (3rd Edition). 206 pages. 13 illustrations. 7-in.×5-in.

(The University Tutorial Press. Price 2/6.)

This book is the practical portion of the theoretical volume in the same series. Like its companion, it deals with its subject in a thoroughly utilitarian manner, and it should find a welcome from all who are working for the examination in question. The exercises are well-chosen and the directions clearly described, and the student who works conscientiously through the book will gain a good grasp of the general principles of chemical analysis.

One cannot help feeling, however, that it is a mistake to divorce so completely the theoretical and practical sides of a science, and that, apart from examination purposes, it would be more satisfactory to have the two portions incorporated in one book.

The table of atomic weights in the appendix also calls for criticism, for the numbers are rounded off and are prefixed by a note to the effect that they are "sufficiently accurate for the purpose of ordinary chemical analysis." Surely it is a mistake to encourage a beginner to aim at a limited degree of accuracy; and, apart from this, the use of such numbers at the outset will be liable to give the impression that the atomic weights stand in closer numerical relationship than appears to be the case from the recorded determinations.

C. A. M.

GEOGRAPHY.

Turkey and the Eastern Question.—By JOHN MACDONALD, M.A. 92 pages. 6-½-in.×4½-in.

(T. C. & E. C. Jack. Price 6d. net.)

This fascinating little book is, if anything, topical; at first it seems merely so. But consideration shows it is the book for the student of the political movements of the age, whose opportunities for study are limited to morning half-hours with his newspaper, for "the man in the street." It would

be a valuable text-book in schools, particularly in Scotland for those reading for the Leaving Certificate in History. It will long remain the concise analysis of the problems of the Near East; of making larger books there will be no end, few will be more useful. It is Anti-Turk, but not partisan, and carries conviction because its argument is built on sound foundations of geography, ethnology and moral and economic evolution.

The first few chapters, the most impersonal, are thrilling. They deal with the evolution of the Balkan Problem, and raise a host of interesting questions. Next, the present situation and its prophase are treated. The last three chapters, the most interesting, discuss the future, and give an instructive comparison between Turkish rule in Europe and in Asia, and British rule in India.

To this volume one would wish a few words of preface. The credentials the author now and then presents in the work would be welcomed in a foreword, setting out his purpose: one resents their intrusion into the text. A few dates given prominently would help the reader to keep his bearings and maintain his grasp. Phraseology requires amendment here and there, as on pages 72 and 78.

A. S.

Atlas of the World.—By J. BARTHOLOMEW, F.R.G.S. 56 pages. 39 maps. 6½-in.×4½-in.

(T. C. & E. C. Jack. Price 6d. net.)

It is questionable whether an atlas is within the scope of such a series as "The People's Books," or can attain its general standard of usefulness. The plates are small, and now atlases with larger maps are available at a price equally low, while larger and more detailed pocket atlases may be had for a shilling. Still, these maps are clear, well-chosen, and quite up to modern standards. They may be of use, for example, in reading other books of the series. The route-chart of Europe is good, and in these days, when history is a-making, a race-chart would also have been valuable. It is a pity that the scale and the projection of each map are not given; particularly on account of the first plate, a note on projection might have been included. Having issued an atlas, it is to be hoped that Messrs. Jack will publish a gazetteer as a companion volume or volumes.

A. S.

Dent's Practical Notebooks of Regional Geography. Book 1. The Americas.—By HORACE PIGGOTT, M.A., Ph.D. and ROBERT J. FINCH, F.R.G.S. 64 pages. 25 maps. 9¾-in.×7¾-in.

(J. M. Dent & Sons. Price 6d. net.)

These notebooks seem to be intended for progressive use in secondary schools and particularly in connection with the geographies by the same authors. They are interleaved atlases of outline maps, some with no detail, others with contours at large intervals and rivers, in order that the relief of the land may be brought out by shading, the drainage worked out, and the whole correlated with climate and political and economic development. Instructions are given on each sheet for the use of the maps and the writing of notes. Some of these appear to supersede the teacher as a thinking being, and teachers who do think will ignore many of them. There is, nevertheless, much useful suggestion and some freshness in these notes. An interesting feature is the inclusion of squared-paper and data for the construction of economic graphs—data, of course, which should not be used exclusively. Unfortunately, the projection is only mentioned in some cases, but for advanced classes its determination in each map would be a useful exercise. Each completed notebook will at once form the best record of the pupil's work on a Continent throughout his school course and his best work of reference for many a day.

A. S.

Memorials of David Livingstone.—16 pages, 6 illustrations. 7¼-in. × 5-in.

(Marshall Brothers. Price 6d. net.)

At present the name of David Livingstone is on every tongue, and people are consulting how best they can pay a tribute to his memory. It is fortunate there are those whose imaginations go beyond tombs and columns as memorials of the illustrious dead. Scotsmen are proposing to establish a Livingstone Chair of Geography in one of their Universities; Churchmen a Livingstone Medical Mission in the sphere of his labours. But already a valuable memorial exists in Livingstone College, Leyton, London, founded in 1893, "to give instruction to foreign missionaries in the elements of medicine and surgery," and so to add very materially to their usefulness. This booklet, issued by the authorities of the College, contains two portraits in colour of Livingstone, the memorial poem printed in *Punch* after his death, and pictures of the inscriptions on his tomb in the Abbey and on the tree, at the foot of which rests the heart of the traveller. The portraits will be valued by many interested in Livingstone, and the purpose of the booklet is to bring before such the aim of the College, and gain their help in an endeavour to raise £10,000 with which to clear off a mortgage, make improvements in the institution, and form the nucleus of an endowment.

A. S.

Cambridge County Geographies. — Forfarshire. — By EASTON S. VALENTINE, M.A. 160 pages. 148 illustrations. 4 maps.

Herefordshire.—By A. G. BRADLEY. 149 pages. 54 illustrations. 4 maps.

Middlesex.—By G. F. BOSWORTH, F.R.G.S. 165 pages. 58 illustrations. 3 maps.

North Lancashire.—By J. E. MARR, Sc.D., F.R.S. 180 pages. 74 illustrations. 4 maps.

Linlithgowshire.—By T. S. MUIR, M.A., F.R.S.G.S. 142 pages. 33 illustrations. 4 maps.

Rutland.—By G. PHILLIPS. 171 pages. 46 illustrations. 4 maps. Each volume being 7½-in.×5-in.

(The Cambridge University Press. Price 1/6 per volume.)

We have on several occasions testified to the excellence of the County Geographies which are being published by the Cambridge University Press. They are books which everyone should read, for many matters of the greatest interest are touched upon, and the word geography is taken to include not merely the physical conformation and political administration of the district, but also the geology, the ethnology, history, and many other details. We are reminded that at Burley, in Oakham, Geoffrey Hudson, the celebrated dwarf, made his appearance before King Charles I, served up in a cold pie, and we also learn that, although he did not reach more than eighteen inches in height until he was thirty, and when he began to grow again never exceeded three feet six inches, he had a most eventful history. On the roll of honour for Middlesex we find the names of Francis Bacon, and Thomas Henry Huxley, while in the volume for this county there is a very interesting account of the natural history of the immediate neighbourhood of the metropolis. Sir Richard Owen is claimed by Lancashire, as well as Sir Richard Arkwright, and among the illustrations which embellish the book on Linlithgowshire are pictures of Linlithgow Palace (where Mary Queen of Scots was born) and the Forth Bridge.

W. M. W.

ZOOLOGY.

The Teratology of Fishes.—By J. F. GEMMILL. 73 pages. 6 illustrations. 26 plates. 12¾-in.×10¼-in.

(Glasgow: Maclehose & Sons. Price 15s. net.)

Till a few years ago structural abnormalities in animals, with the exception of those occurring in certain parts of the skeleton, were regarded by the systematic naturalist as of little or no importance from his standpoint. Nowadays a complete change of view has taken place, and in the present work Dr. Gemmill points how such abnormalities in fishes

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may indicate in a remarkable manner relationships to the higher vertebrates which are not apparent in normal examples. It is, however, to be regretted that he does not appear to have pointed out as clearly as he might have done the nature of such relationships. Trout and salmon, of which the young states are to be procured in any quantity at the hatcheries, afford the great bulk of the material upon which the author has worked. How great has been the labour involved, may be inferred from a study of the beautiful series of photomicrographs with which the volume is illustrated. Facts of the greatest value have, it is stated, been ascertained by this detailed study with regard to the mode of origin and development of the bony fishes; and much interesting information is likewise recorded with regard to the origin and nature of the different types of monstrosity most commonly met with. It should, however, be distinctly understood that the book is essentially one for the professional morphological and systematic student, to whom it will doubtless prove of the highest value.

R. L.

The Vertebrate Skeleton. Second edition.—By SIDNEY H. REYNOLDS, M.A. 535 pages. 144 illustrations. $5\frac{3}{4}$-in. × $9\frac{3}{4}$-in.

(The Cambridge University Press. Price 15/- net.)

Professor Reynolds' book on the Vertebrate Skeleton has proved of such value that a second edition has been called for, and in it an attempt has been made to bring it up to date. Professor S. W. Williston has revised the section devoted to reptiles, practically re-writing Chapters XIII and XVI, and making other contributions. A number of new illustrations have been introduced, and those students who want a succinct account of the skeleton, whether external or internal, of vertebrates, will have it ready to their hands. The beginner is advised to start with the skeleton of the dog-fish, and then pass to those of the newt and frog, and after to that of the dog. Other skeletons which are described in detail are those of the codfish, green turtle, crocodile and wild duck; the remaining parts of the volume being devoted to the various classes and general accounts of their skeletons.

W. M. W.

NOTICES.

PHOTO-MICROGRAPHY. — We have pleasure in announcing that Mr. Edgar Senior will give a course of six practical demonstrations on photo-micrography at the South-Western Polytechnic, on Monday evenings from 7.30 to 9.30 p.m., beginning on May 5th. Special attention will be given to the photographing of etched surfaces of metals and alloys, but the course will also be arranged to suit the requirements of students of geology and botany, and those wishing to use their own microscopes to obtain photographic records.

PHYSIOLOGICAL HISTOLOGY.—Messrs. Carl Zeiss are issuing in ten parts an illustrated book on Physiological Histology of Man and Mammalian animals, each of which is accompanied by ten microscopical preparations. The first of these, which is before us, deals with the skin and cutaneous organs and is exceedingly well got up, while the slides, which we have examined, are excellent. We may add that the work has been undertaken by Professor Doctor Sigmund, and the English edition has been prepared by Mr. C. Lovatt Evans, of University College, London.

THE LIGHTING OF OPERATING THEATRES.—Of special interest to surgeons is the system of concentrating light in operating theatres introduced by Mr. E. Leitz. In the past, to get over the difficulties of lack of daylight, arc lamps have been used, but these cause the hands and instruments to cast deep shadows which may obscure the field of operation and even the use of more than one lamp does not do away with this entirely, while only a small fraction of the light from them reaches the operating table. In the system already alluded to the rays from one arc lamp are concentrated upon the operating table by six separate reflectors and so much light can be made available that an iris diaphragm has been fitted to the apparatus for cutting it down.

THE NATURALIST'S DIRECTORY.—A new edition of "The Naturalist's Directory" is now being compiled by Mr. S. E. Cassino, Salem, Mass., U.S.A., and will be published in the fall of this year. This valuable work has been published every few years since 1880, and comprises the names and addresses of all English-speaking Naturalists, as well as full particulars of the subjects in which each is interested. Every Naturalist who has not received blanks should send his name and address and full particulars, as well as the names of any friends and acquaintances. To those who are actively working at any branch of Natural History, the importance of having their name in this directory is obvious, for announcements of new literature in connection with their subject will reach them, and they will be brought into touch with fellow-workers in all parts of the world.

MESSRS. J. H. DALLMEYER, LIMITED, having removed from 25, Newman Street to 19, 21 and 23, Oxford Street, close to the Tottenham Court Road stations of the Central London and Hampstead Railways, and near the junction of Charing Cross Road with Tottenham Court Road and Oxford Street, all communications for the show-rooms and London Offices should be addressed to 19, 21 and 23, Oxford Street, W.

In their new home this famous firm of Dallmeyer, established for over fifty years, are showing a large and varied stock of photographic lenses, cameras and shutters, kinematograph lenses, telescopes, telephoto lenses, and so on, all of which are of the high standard of quality which has made the name of Dallmeyer famous throughout the world. As the firm extends a cordial invitation to inspect its new premises, we would advise all those who are able to do so to take an early opportunity of paying them a visit.

THE ALCHEMICAL SOCIETY.—The third general meeting of the Alchemical Society was held on Friday, March 14th, at 8 p.m., at the International Club, Regent Street, S.W. The chair was occupied by the acting President, Mr. H. Stanley Redgrove, B.Sc. (Lond.), F.C.S., and a paper dealing with the interpretation of Alchemy in relation to modern scientific thought was read by Mr. Sijil Abdul-Ali. The lecturer pointed out that the alchemists in general appeared to have adopted the Hermetic method of reasoning from universal to particular judgments, although there were sporadic indications in the literature of a quite scientific and rational empiricism. The fundamental concepts of their philosophy were, he said—(i) A "First Matter" or "Hyle," containing implicitly the four elements which were subsequently to issue in manifestation; (ii) Four elements (viz., earth, water, air and fire), which, by mutual combination, produced the three principles (viz., sulphur, mercury and salt), whose varying combinations gave rise to the different properties of bodies; (iii) A certain divine spirit or essence, called "The Soul of the World," which was immanent in all created things; and (iv) A mediate spirit, called "The Spirit of the World," by which the soul acted upon and was bound to its body (*i.e.*, matter). The lecturer compared and contrasted these concepts, in a most interesting manner, with modern scientific theories concerning—(i) A possible dual Protyle, or first matter; (ii) The solid, liquid, gaseous, and incandescent gaseous states of matter; (iii) Energy; and (iv) The ether of space. The full text of the lecture and an abstract of the discussion which followed appears in the March number of *The Journal of the Alchemical Society*.